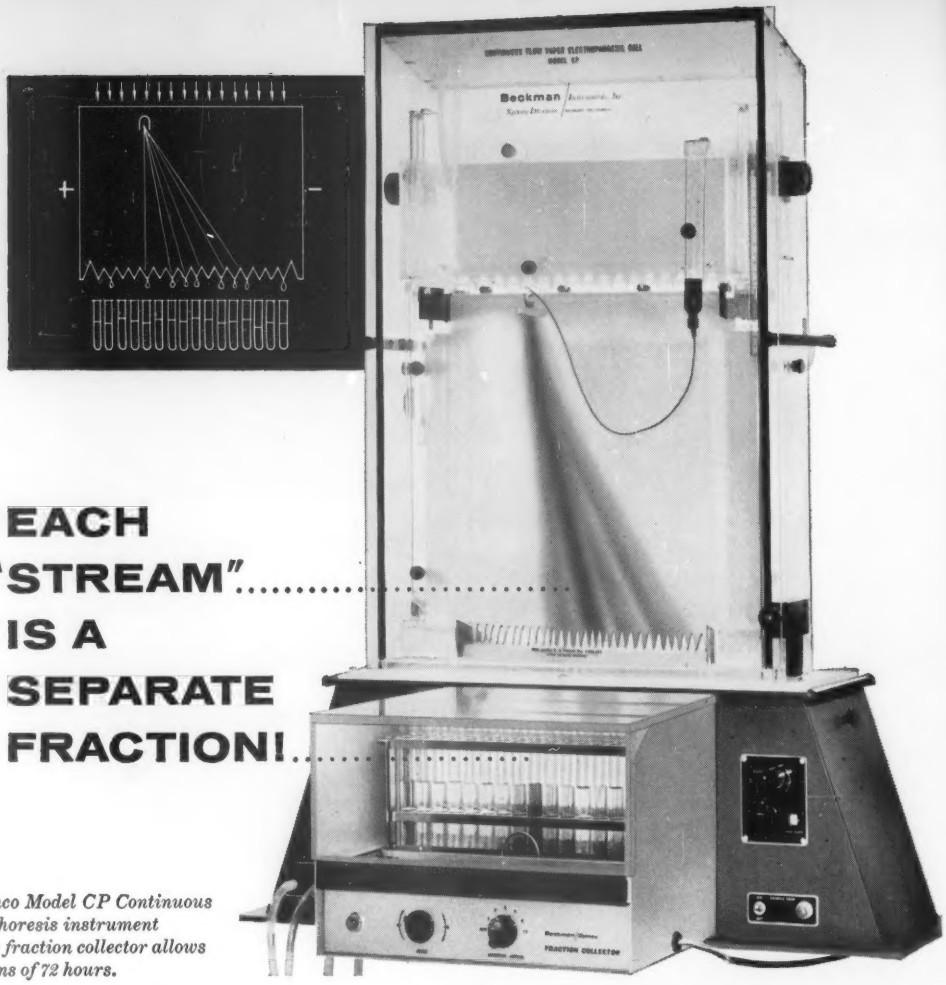
SCIENCE

22 January 1960
Vol. 131, No. 3395

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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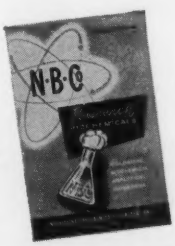

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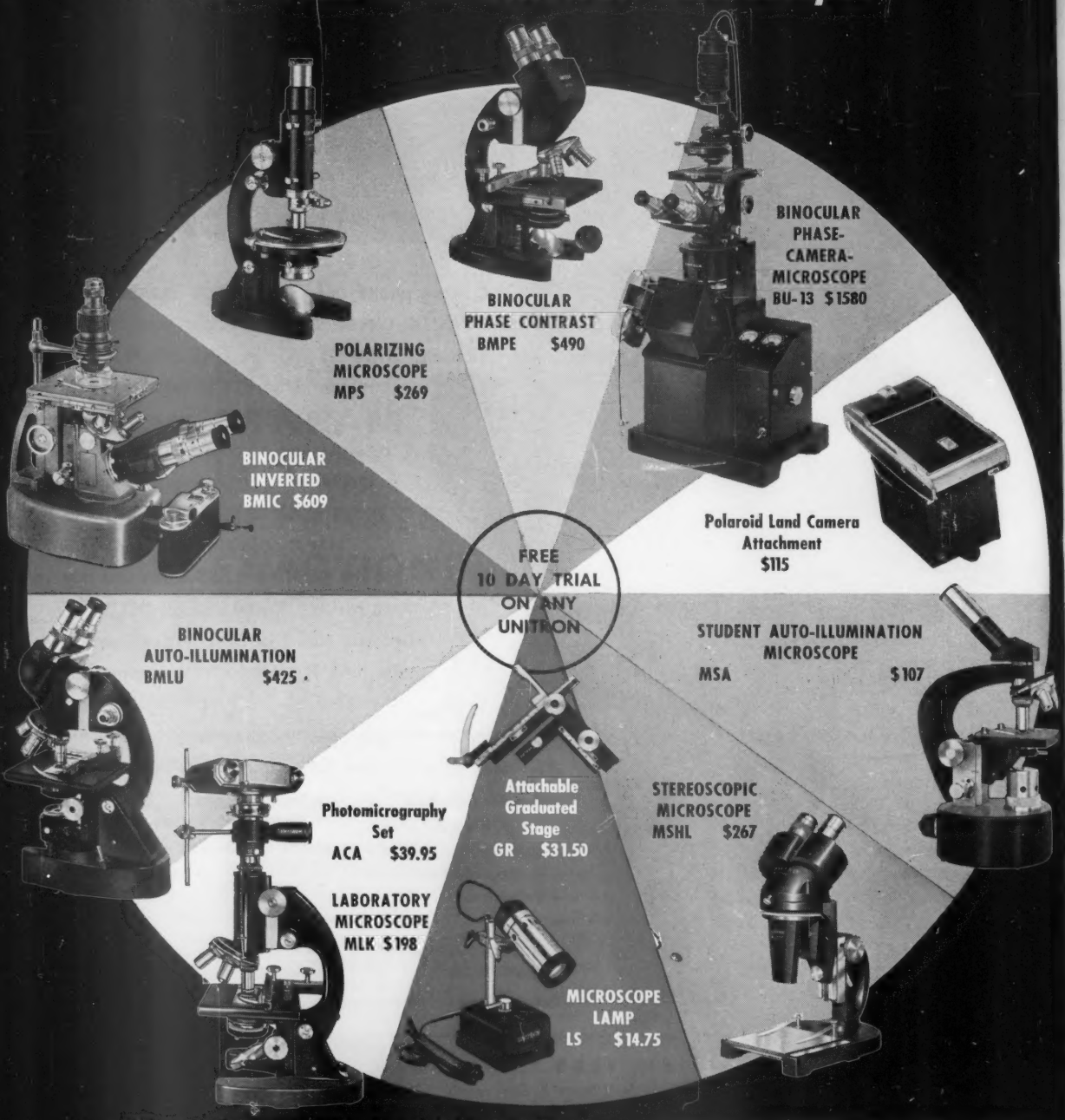

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Cover A Navajo weaver spins wool for a rug by a method employed for many centuries. Rug weaving continues to be important in the economy of the Manyfarms-Rough Rock area. See page 197. [Milton Snow, Bureau of Indian Affairs, Window Rock, Ariz.]

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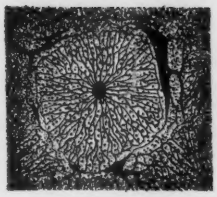
a glance at yesterday in relation to today



IN JANUARY—(1930)—proof is offered of a glucose-lactic acid cycle involving liver and muscle. Glucose and lactate determinations were done on blood drawn from the femoral artery, femoral vein, hepatic artery, and portal vein of dogs at rest and during moderate exercise. The data suggest that lactate released into the blood stream by muscle is removed by the liver and converted to glucose. The glucose returns to the blood stream where it is again taken up by skeletal muscle.

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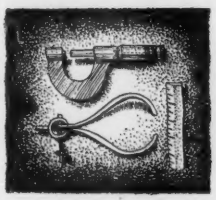

IN JANUARY—(1933)—Science reports the determination of the size limits of the gene, announced to the A.A.A.S. by Gowen and Gay of the Rockefeller Institute. Dividing the amount of chromatin (in Drosophila chromosomes) by the number of genes (as determined by the mutation rate) they calculate the maximum gene size as 10^{-18} cubic centimeters.

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1. Himwich, H. E., Koskoff, Y. D. and Nahum, L. H.: Studies in carbohydrate metabolism I. A glucose-lactic acid cycle involving muscle and liver. J. Biol. Chem. 85:571 (Jan.) 1930. 2. Science News: Science 77:8 (Jan. 6) 1933. 3. Lockart, R. Z., and Eagle, H.: Requirements for growth of single human cells. Science *129*:252 (Jan. 30) 1959.

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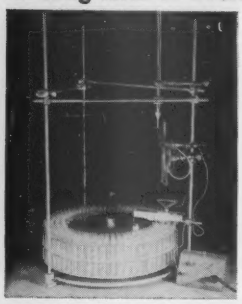

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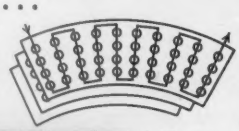

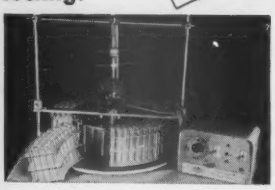

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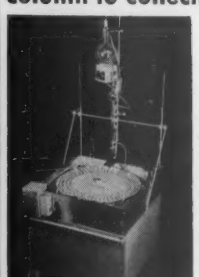

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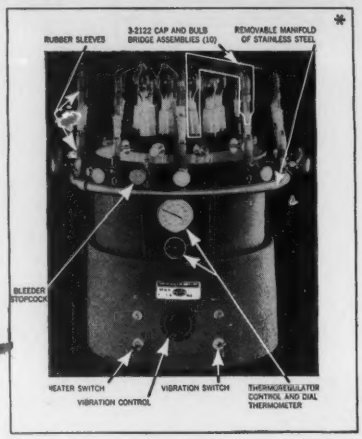
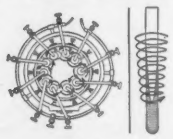


FEATURES

- Controlled circular vibration creates deep swirling to prevent "bumping" during heating under vacuum.



vortex created by eccentric motion of unit

Arrows indicate eccentric motion of unit

- Internal variable voltage transformer controls vibration rate.
- Simultaneously evaporates 10 test tubes or centrifuge tubes, 16-25 mm diameter.
- Connects to efficient water aspirator as vacuum source.
- Automatic thermoregulator controls temperature of water bath.
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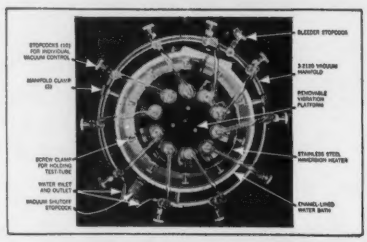

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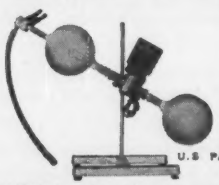

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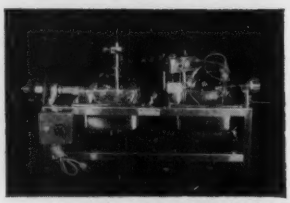

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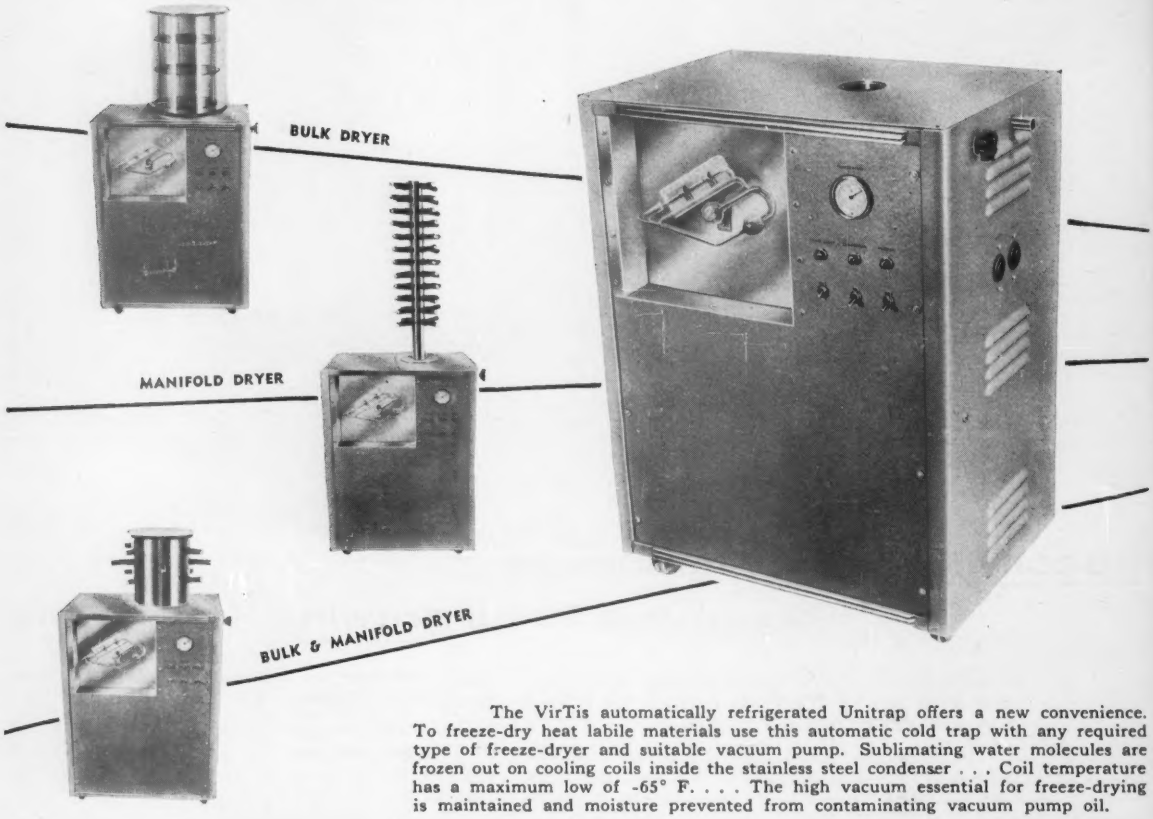

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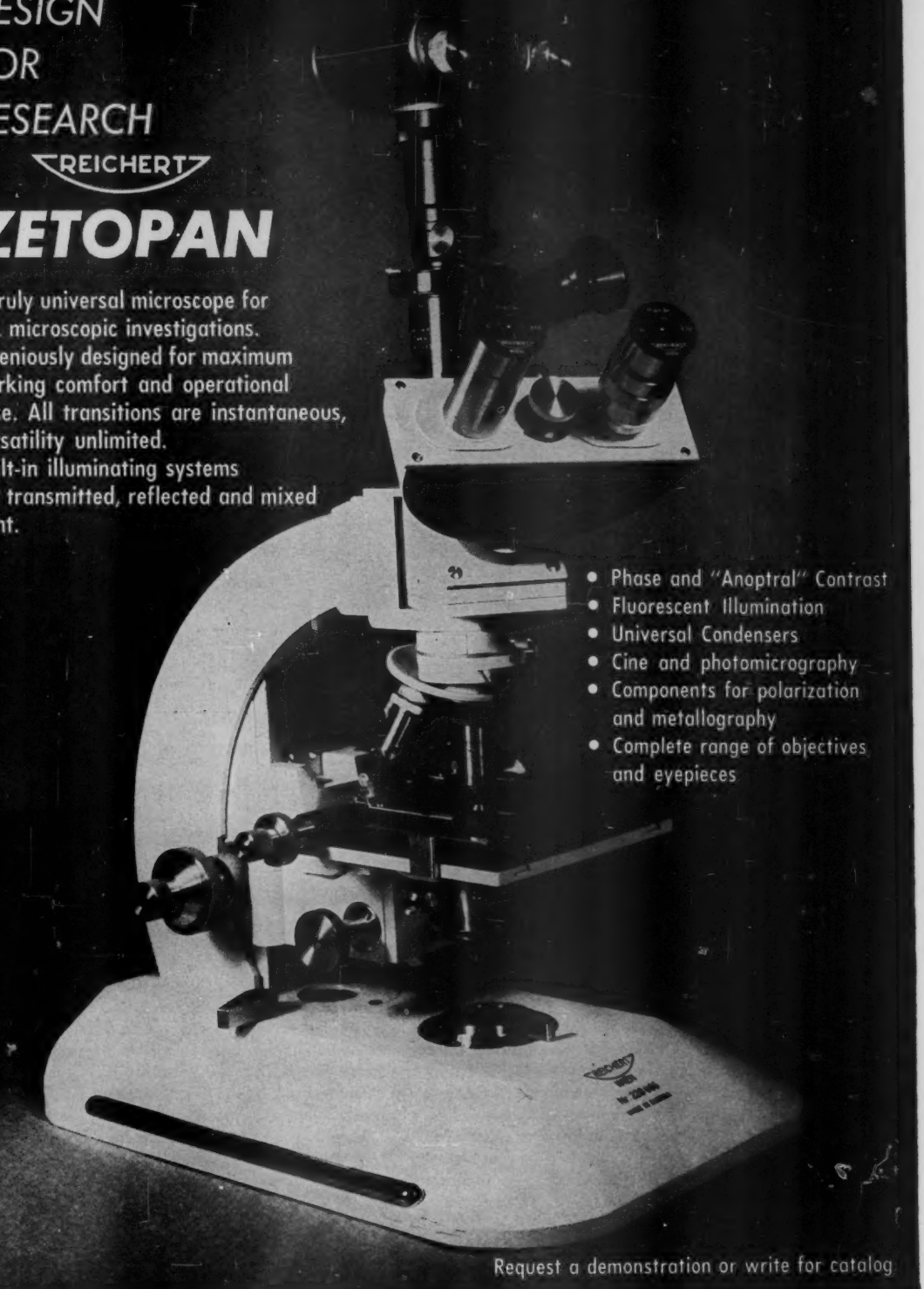

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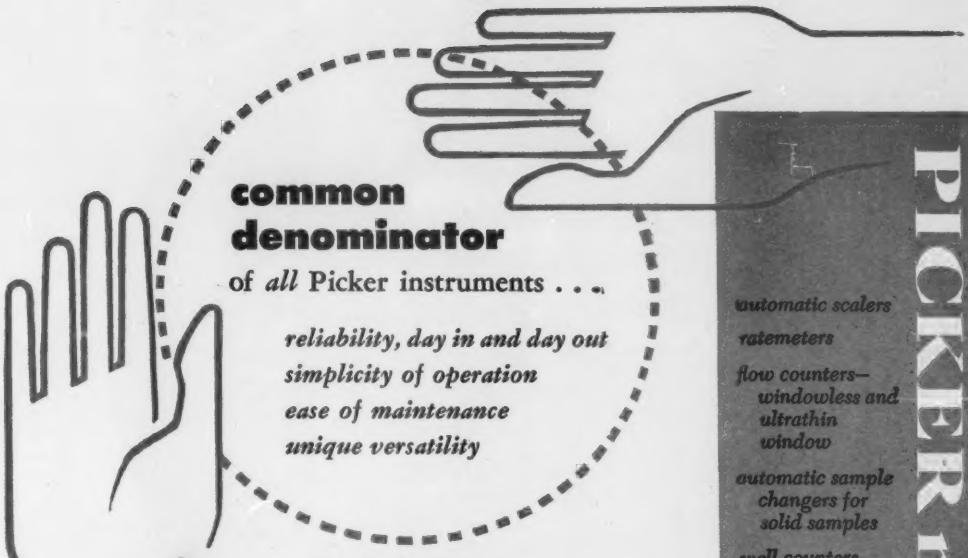

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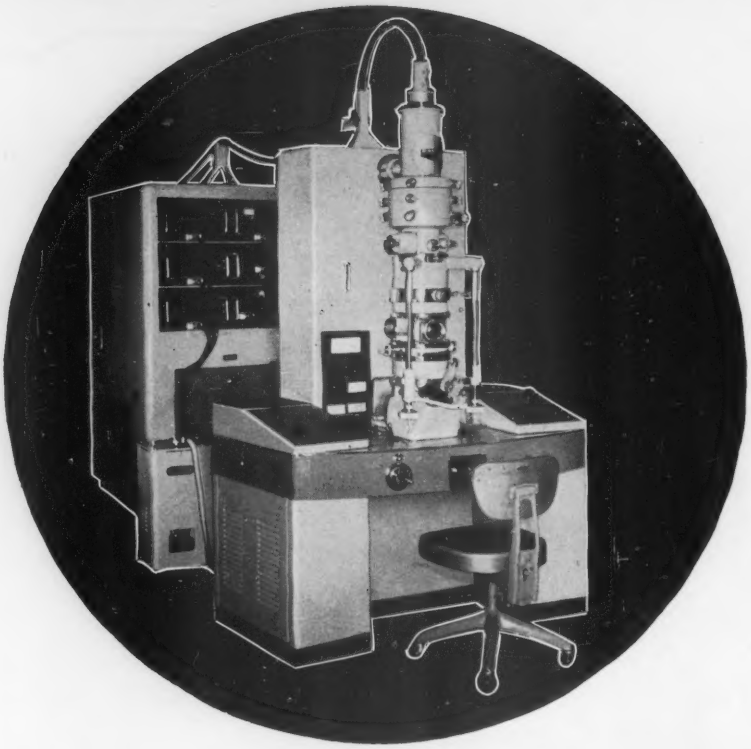

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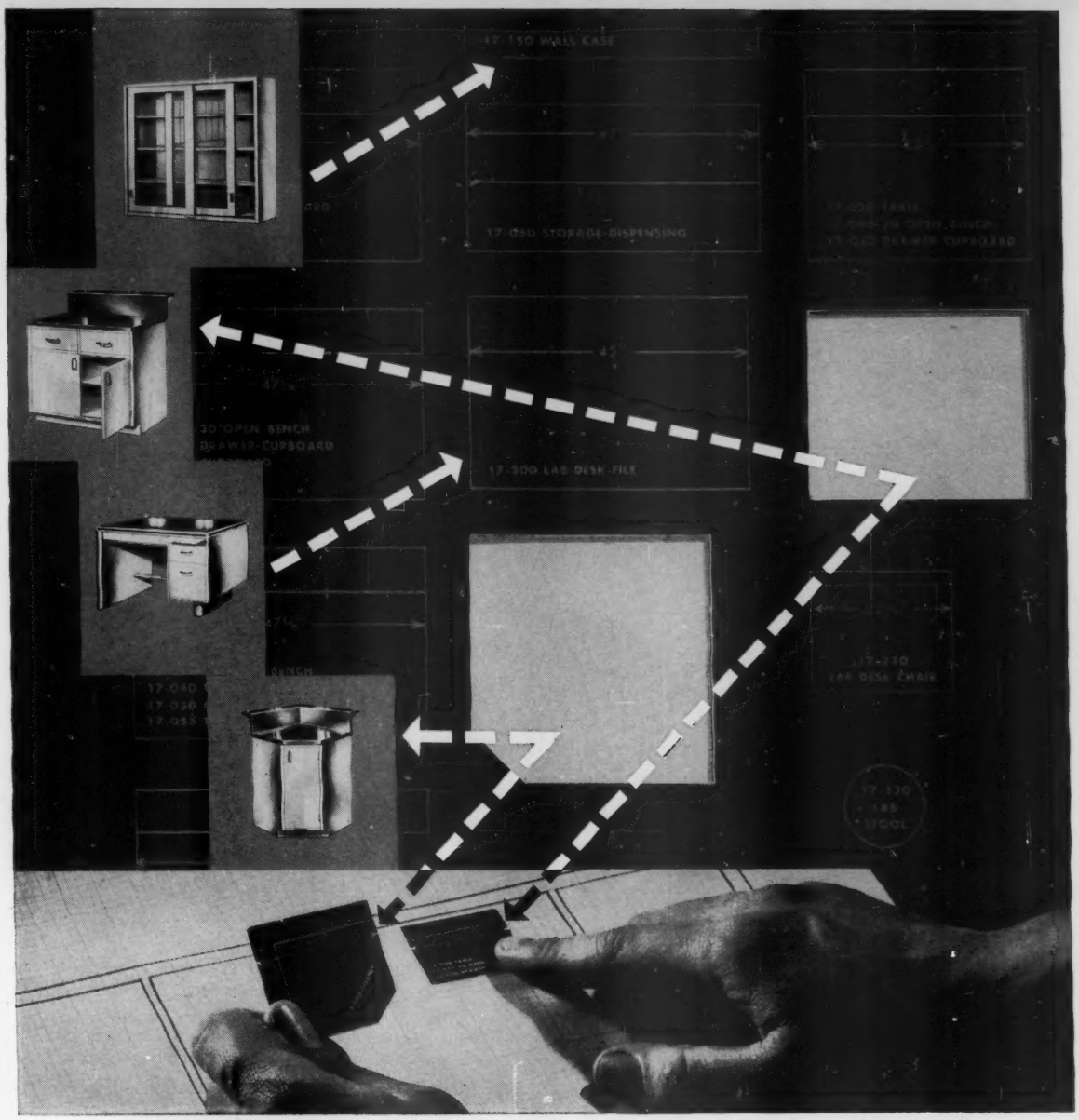

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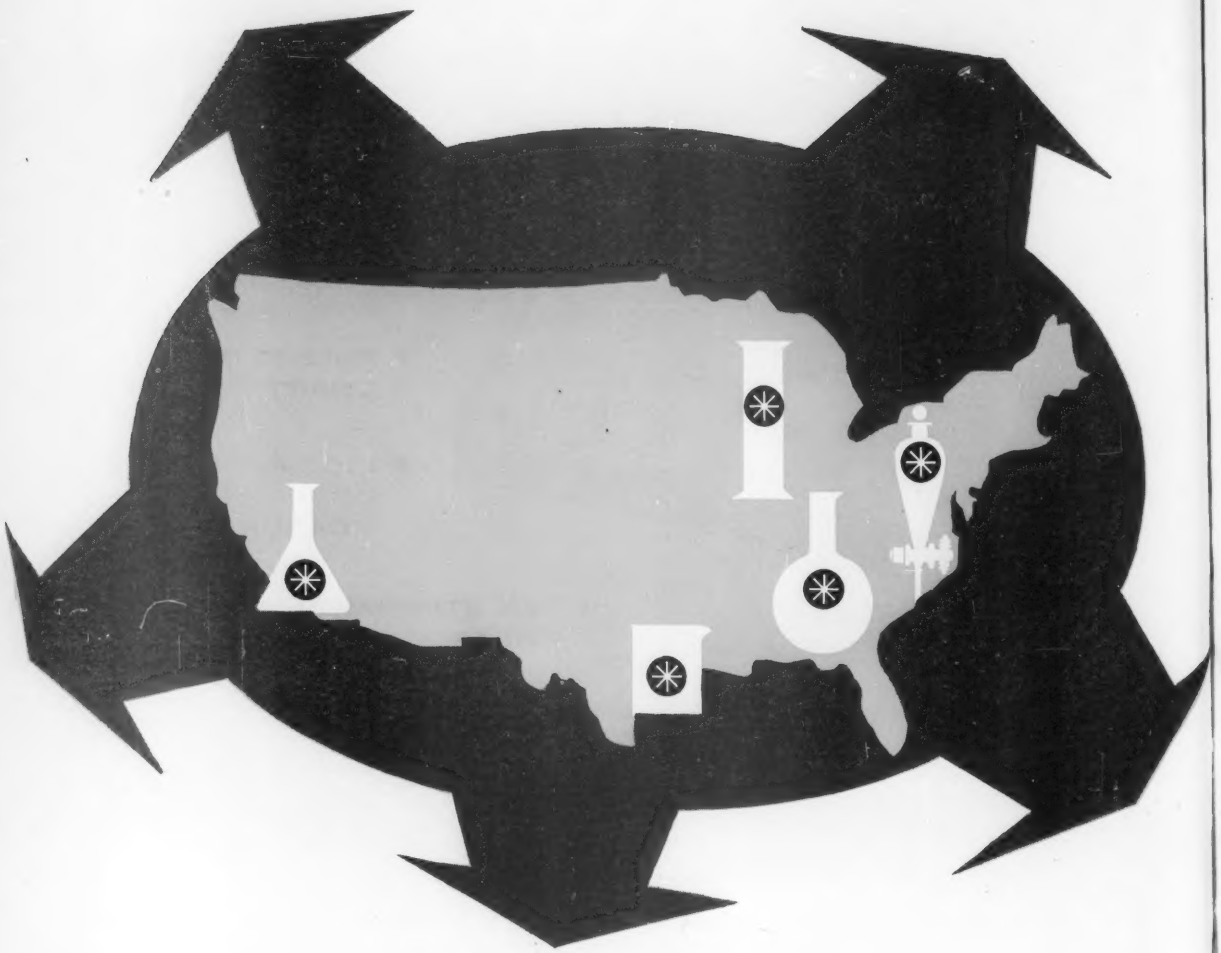

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Metric versus English Units

The metric system has some undoubted advantages over the English system of weights and measurement. Generation after generation of school children would find it easier to learn and easier to use. Scientists prefer it; among the small number of self-selected respondents to an American Geophysical Union questionnaire, 90 percent consider a change to metric units desirable, and 68 percent believe the change inevitable. They may be right, but conversion would pose a complex problem of balancing some attractive gains against some serious disturbances and losses. How much time saved in learning and using the simpler system is worth how much cost in plant conversion, dual inventories, and difficulties of abandoning a system deeply entrenched in milk bottles, machine tools, land titles, textbooks, boxcars, store scales, and in replacement parts for countless items built to English unit specifications?

Several recent attempts to balance the gains against the losses have resulted in different conclusions. Some countries have converted to the metric system. A New Zealand parliamentary committee has recommended decimal coinage and urged that if that recommendation is adopted it be followed by a study of decimalization of all weights and measures. A committee of the British Association for the Advancement of Science has studied the matter for over two years without deciding what to recommend. A committee of the American Geophysical Union recommends compulsory adoption of the metric system by the end of a transition period of 33 years, one generation. The AAAS Committee on Metric Usage has recorded its opposition to compulsory conversion. These different groups have obviously given different weights to the arguments pro and con.

Some aspects of conversion would be comparatively simple. Quart bottles could be retired in favor of liter bottles, and householders could learn with relative ease to buy meat and potatoes—and to watch their own weight—in kilograms instead of pounds. Similarly, some industries could switch fairly readily, as a good proportion of the chemical and pharmaceutical industries have demonstrated.

In other fields conversion would be difficult. Until the furnace and the plumbing system wear out, householders will need nuts, bolts, pipe fittings, and repair parts measured in English units. Manufacturers of machine tools, printing presses, and other durable equipment would have to provide dual inventories, or, if they did not, would antagonize customers and invite competitors to step into the market they had abandoned.

Following close on the heels of the basic question of balancing the gains against the costs are other questions. Should the U.S., the U.K., and the British Commonwealth act in unison, or reach their own decisions independently? If a change is made, should it be mandatory, and if it is not mandatory will it ever be made? Should the rest of the nation subsidize those segments of industry that will incur the heaviest transitional costs? Is there coming to be sufficiently good agreement on other units, for example, an inch of exactly 2.54 cm, that the advantages of the metric system are no longer as great as they once were? Does the widespread interest in science make the present a particularly good time to start? Advocates on both sides of the basic issue may soon have an opportunity to advance their arguments, for Congress may this year call for a thorough study of the problems and the advantages of adopting the metric system.—D.W.

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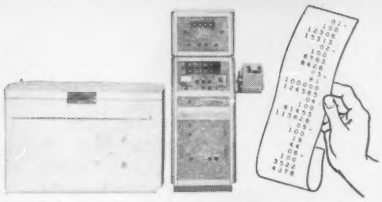

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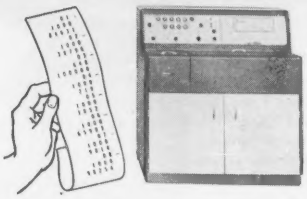

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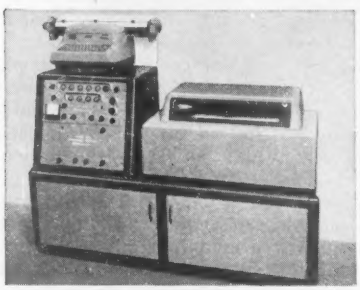

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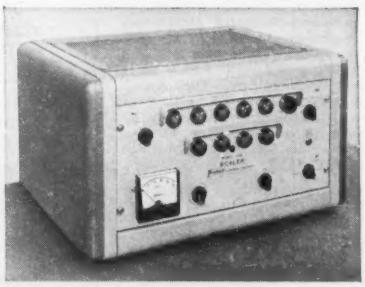

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22 January 1960, Volume 131, Number 3395 SCIENCE

Introducing Modern Medicine in a Navajo Community

Physicians and anthropologists are cooperating in this study of changing patterns of culture and disease. The first of two parts.

Walsh McDermott, Kurt Deuschle, John Adair, Hugh Fulmer, Bernice Loughlin

Technologic development in the sense of the natural spread of a technique from one part of the world to another is presumably as old as man. Organized attempts to introduce technologies to a people either within or outside of the introducer's own country are likewise not new. Features today that are quite new, however, are the sheer size of the international technologic development movement, the changed sovereignty relationships of many of the recipient peoples, and the recently developed power to make rapid and truly significant changes in the status of their health. As health and agriculture (along with education) are the principal targets of most programs, the impact of technologic development today may be as much biologic as it is economic.

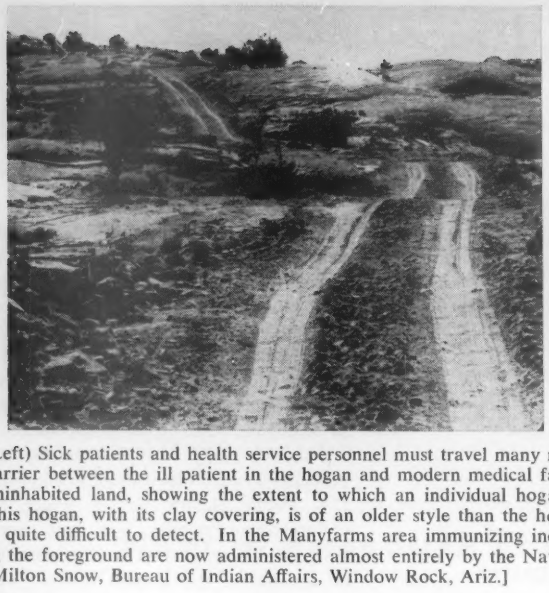
Of necessity, in such a hurriedly expanding international activity, the power to effect such widespread biologic and social changes must be wielded without much of the body of knowledge essential for its proper application. Thus, the activity carries with it the potential for harm as well as good.

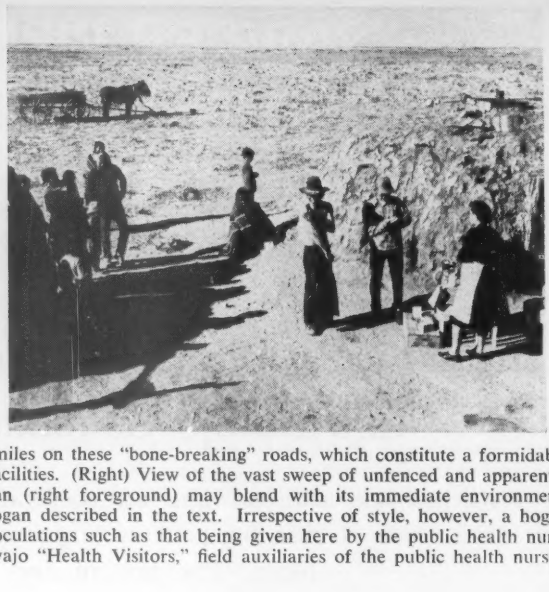
The social scientists were quick to perceive this point, and there is now a rapidly expanding research effort being conducted by them on various aspects of the broad question of technologic development (*1*). The social scientists can penetrate only so far, however, into the biologic aspects of the subject, and there has been relatively little research by medically trained investigators on what might be termed the "medical" aspects of technologic development. Indeed, some of the most important questions are of a nature that neither the social scientist nor the medical scientist is properly equipped to study alone. For example, with today's drugs it is possible to place in the hands of a barefoot, nonliterate villager more real power to affect the outcome of a child critically ill with, let us say, meningitis or pneumonia or tuberculosis than could have been exerted by the most highly trained urban physician of twenty-five years ago. This is a "technologic development" with truly great potential for either good or harm. Yet its full implications cannot be appropriately explored by either the social scientist or the medical scientist working alone. Moreover, in the usual course of events, even when the two are working together, as in the case of an operating program in the field, the requests for the physician to provide medical services to the people are usually so great that he is seldom able to participate in research.

In view of the importance of the basic issue, however, it seems wholly proper that attempts be made to subject some of the relevant questions to scientific scrutiny. Accordingly, in 1955 such an attempt was started, to utilize jointly the skills of the medical and the social scientists in a systematic investigation of the broad question of technologic development as it applies to medicine. The opportunity to initiate such a study was provided by the Navajo Tribal Government and the U.S. Public Health Service, which by congressional action had just been assigned responsibility for the health of Indians in the United States. The cultural, geographic, economic, and medical situations of the Navajo in 1955 closely resembled the corresponding factors in many economically underdeveloped areas of the world (*2*). An opportunity was thus provided to do two things: to try to assist our government in its attempt to improve the situation of one of our own minority groups, and to study, from a vantage point not attainable in an operating governmental program, the wide variety of problems in this complex question of technologic aid to economically underdeveloped countries.

In this article, in the interest of brevity, all discussion is omitted of such topics as the many steps involved in the choice of the project area; the negotiations with the Navajo tribal leaders and with the people of the area chosen; the organization of the project; and relationships of the project to the governmental activities in the larger Navajo area. These are all subjects of very considerable importance in the studies, but they will be presented elsewhere in detail. Suffice it to say (i) that the area chosen is representative in terms of both culture and terrain and consists of the 800-square-mile Manyfarms-Rough Rock area, with an estimated population of more than 2000 people; and (ii) that

The authors are affiliated with the Department of Public Health and Preventive Medicine of the New York Hospital–Cornell University Medical Center, New York, N.Y. Miss Loughlin is also affiliated with the School of Nursing. This article is adapted in part from the Edward Jenner memorial lecture delivered by Dr. McDermott at St. George's Hospital Medical College, London, 1 July 1958.





(Left) Sick patients and health service personnel must travel many miles on these "bone-breaking" roads, which constitute a formidable barrier between the ill patient in the hogan and modern medical facilities. (Right) View of the vast sweep of unfenced and apparently uninhabited land, showing the extent to which an individual hogan (right foreground) may blend with its immediate environment. This hogan, with its clay covering, is of an older style than the hogan described in the text. Irrespective of style, however, a hogan is quite difficult to detect. In the Manyfarms area immunizing inoculations such as that being given here by the public health nurse in the foreground are now administered almost entirely by the Navajo "Health Visitors," field auxiliaries of the public health nurses. [Milton Snow, Bureau of Indian Affairs, Window Rock, Ariz.]

the Navajo Tribal Council has annually appropriated $10,000 to $20,000 as its contribution to the research, in addition to the financial support provided by Cornell University, private foundations, industry, and the U.S. Public Health Service (*3*).

In what follows, the research program is presented in brief outline, with the primary aim of describing the complex background, the goals, and the scope of the studies. In addition, the three-year results in a few of the projects are singled out for brief discussion. First, however, it is necessary to describe certain features of Navajo society, especially as they pertain to matters of health (*2, 4*).

Navajo Style of Life

The Navajo tribe of approximately 85,000 members is only one of the more than 200 Indian tribes in the United States, which altogether include some 400,000 people. Unlike many of these tribes, the Navajo live on their own ancestral land, which is located principally in northeastern Arizona, with extensions into Utah in the north and into New Mexico in the east. The Navajo area consists of 23,574 square miles (*5*) and is thus larger than eight of the states. The land is relatively inaccessible, because it is up on a plateau, away from the main stream of travel and transport. This in part explains why the Navajo have managed to remain secluded for so long. The terrain consists of mesas and canyons interspersed with vast sweeps of flat, semiarid, unfenced plain. Because the area has an elevation of from 6000 to 8000 feet above sea level, the climate is rigorous at times, and it can be bitterly cold after sundown in the winter. During most of the year the midday sun is warm.

The Navajo do not live in villages; instead, the individual family units are located several miles from each other, frequently in relatively inaccessible canyons. The 85,000 people scattered over this vast area are linked to each other and to modern health facilities by a network of roads, all but two of them unpaved (*6*), that vary from the merely terrible to the completely impassable. At times the roads go out over sheer naked rock. At other times, a reasonably satisfactory dirt road will be completely severed within a few hours by the flash floods that occur frequently in this mountainous, semiarid plateau.

The usual dwelling unit is the hogan, which is a six- or eight-sided windowless log-and-mud dwelling with a dirt floor and a central smoke hole in the roof. In the interior of the hogan there is usually one bed, and the other members of the family sleep on sheepskins on the dirt floor. The infants are securely laced and carried on cradle boards. The cooking is sometimes done over an open fire, but more often on a stove constructed from a gasoline drum, or on a manufactured stove. Tables and chairs are not generally employed.

The individual dwelling units have no water supply. All water for the entire family must be hauled over the dirt roads by wagon or "pickup" truck for distances of a few to as many as ten miles from the nearest spring, trading post, or livestock tank. There are no privies or latrines. Fecal contamination of the dirt floor of the hogan by the infants is common. The adult practices with respect to the disposal of feces, although "primitive," are relatively sanitary. Defecation is usually done at a considerable distance from the dwelling, and the fecal material is carefully buried. The sand and hot sun serve to render the fecal material relatively harmless.

It should be emphasized that the great majority of adult Navajo and most of the preschool children have no knowledge of the English language. Moreover, the Navajo language is not a written one. A written version has been constructed in recent years by language scholars, but it is used by very few Navajo. Consequently, almost without exception all work in medicine and the other technologies must be carried on through interpreters, who vary greatly in proficiency.

As recently as six years ago there were many thousands of children of school age who had no chance at all to obtain even one year of schooling. Although this situation has been changed considerably, in the 1959–

1960 school year there were still approximately 3000 children of school age who were out of school. There remains, moreover, a large backlog of adolescents and young adults who have received no schooling, or very little.

The Navajo are United States citizens by birth and are completely free to enter or leave their communally owned land without notice to anyone. Relatively few Navajo, however, are able to meet the Arizona literacy requirements for voting in national and state governmental elections; and most members of the tribe are residents of Arizona. The balloting in the tribal elections, which have become quite important in recent years, is done by selection of candidates by picture.

The Navajo earn their living by raising sheep, weaving rugs, working silver, and doing a little dry farming, and through migratory off-reservation employment on the railroad or in harvesting crops. When the man of the family goes off the reservation for railroad employment he usually leaves his family at home, but they may accompany him for crop harvesting. The people are eligible for aid from state and federal welfare programs, just like any other citizens, after meeting the same requirements. In actuality, in the Manyfarms-Rough Rock area, the United States Government program that exerts the greatest influence on the dollar economy appears to be the federal old age and survivors program. This fact has important implications with respect to the position of the elderly in Navajo society.

Despite the efforts of Christian missionaries dating back to the 17th century, the Navajo religion is very much a going concern today. Moreover, when considering medical matters it is important to recognize that health occupies a most important position in Navajo religion, and that the healers or medicine men are also the spiritual leaders.

In very elementary terms, all this may be summarized as follows: The Navajo stay on their ancestral land and raise sheep, thus overgrazing the land so that it blows away and is subject to flash floods which make the roads impassable so that the children cannot get to school to learn English. Hence, they cannot successfully compete in the world outside the reservation and must of necessity stay home and raise more sheep.

It would be quite misleading, however, to give the impression that the Navajo form a disintegrating society. On the contrary they are a lively, vigorous tribe that has only recently become aware of itself as a tribe. They have excellent tribal leaders who realize that the world has much to offer. These leaders work with (and sometimes belabor) the responsible United States Government officials, and the two groups together are steadily improving the situation. In the past few years the tribal income—that is, the funds available to the tribal government from its own resources (lumber, minerals, oil)—has considerably increased. The tribal leaders have bravely resisted pressures to make a direct per capita "handout" of these funds and have organized a series of integrated tribal programs in such fields as education, health, and the development of water supplies and other natural resources. What can be said today is that in tribal desires and expectations, as in culture and terrain, the situation of the Navajo is a replica in miniature of conditions in many parts of Asia, Africa, and South America.

Scope of the Study

In May 1956 the study under discussion went into actual operation in the 800-square-mile Manyfarms-Rough Rock area in the approximate center of the Navajo territory. There were four avowed purposes: (i) to define the proper concerns of a health program among a people such as the Navajo; (ii) to find ways to adapt concepts of modern medicine for presentation in an acceptable form across formidable cultural and linguistic barriers without compromising essential medical standards in the process; (iii) to study, in so far as possible, the biologic and social consequences of this innovation in terms of the community (and the outside participants); and (iv) to see whether information of importance with respect to environment and disease in our present-day society can be obtained from study of a people who are emerg-

Road through a relatively accessible canyon in which hogans are situated. Although not considered difficult in dry weather, this road can become completely impassable within an hour after a flash flood. [Milton Snow, Bureau of Indian Affairs, Window Rock, Ariz.]

A hogan, with mesas in the background. The notched logs in the foreground are for building a log cabin; firewood is stacked at right. At one time this camp was one of a very few with a well (the low stone structure at left of the hogan), but this is now "sanded in," and hauled water is stored in the gasoline drum in front of the hogan. [American Museum of Natural History]

ing from a relatively primitive society and becoming part of the rural United States of today.

The total program may be considered in terms of three large general studies and a greater number of smaller and more sharply defined studies. To some extent this classification is arbitrary. In reality, the three general studies all tend to merge; conversely, the segmental or categorical studies have a way of developing subcategories once experience is gained in the study of a particular question.

The first of the three general studies consists of a socioeconomic study of the community as a whole, with special reference to factors that might be relevant to a consideration of health and disease. The second study has to do with defining the pattern of disease in the community by performing complete physical examinations and appropriate laboratory studies on the individual members of the community. The third of the general studies is concerned with determining to what extent Navajo men and women with limited schooling can be trained to function as effective field auxiliaries of the public-health nurses.

The use of the word *community* might be questioned when applied to 2000 people scattered over an 800-square-mile area. The term seems justified, however, by the fact that the residents of Manyfarms and Rough Rock avowedly regard these two adjacent areas as "communities" to which they respectively belong, and the two areas together form an electoral district with a single seat on the 74-member Navajo Tribal Council. Representatives from the electoral district as a whole organized the exercises held at the inauguration of the project, at which time the medical facilities were "blessed" in appropriate religious ceremonies by Navajo medicine men. There is similar district-wide representation on the Chapter (*7*) health committee (several medicine men are members), so that this committee, with which the research staff consults, nominally speaks for the residents of the entire 800-square-mile area.

Demographic Studies

The socioeconomic studies have revealed information about the Manyfarms-Rough Rock community of the same general sort as that presented above in the general description of Navajo society. The demographic data are of particular interest, however, because they are believed to represent the first reliable measurement of a Navajo birth rate. Formidable difficulties exist with respect to obtaining such information when an unknown proportion of births occur in remotely situated hogans. It was necessary, therefore, to expend a far greater effort in obtaining these data on births and deaths than would ordinarily be feasible except as a part of a research project.

The number of live births was 94 in 1956, 98 in 1957, and 94 in 1958 in a population that totalled 2048 on 1 January 1959. Thus, the average anuual birth rate over the three-year period was 48.7 per 1000 persons. This extraordinarily high birth rate was associated with a high fertility rate—that is, the number of live births per 1000 women aged 15 to 44. At the census point (1 January 1959) there were 436 women in this age group in the community. With a total of 286 live births (annual average, 95.3) during the preceding three years, the fertility rate was approximately 220 (*8*). Of this total of 286 live births, 48 percent occurred outside the hospital.

During the same three-year period

(1956–1958) there were 47 deaths, or an average of 16 deaths per year in the community. This represents a death rate of 7.3 per 1000 of the Navajo population. The infant mortality rate (deaths during the first year of life per 1000 live births) was 73.1.

The information on deaths among the Navajo was even more difficult to validate than the data on births. In general, the major portion of a death rate is made up of deaths in the early years, especially in the early months, of life. It is this segment of the death rate that was so difficult to obtain. For in the Navajo country when a birth has occurred at home without medical or nursing supervision and the infant dies in the first few weeks of life, it is not at all unusual for the family to make no report of the event to the governmental authorities. There seems to be nothing particularly surreptitious about this. It is simply that members of the family appear to regard the death of their infant wholly in personal terms and hence as something of no conceivable interest to health authorities.

Accurate information on the rate of population increase is obviously of vital importance in technologic development programs, particularly in the planning for facilities in education and health. It is of considerable interest, therefore, that the concentrated study made on a continued basis in the 800-square-mile sample area revealed a birth rate so much higher than the official Navajo birth rate recorded for the tribe as a whole on the basis of routine reporting. For 1956, the official recorded birth rate for the tribe as a whole was 36.3 per 1000 (*5*), in contrast to the rate of 49.6 for that same year in the sample area. Moreover, the annual rate of population increase during the three-year period in the sample area (4.0 per-

The interior of a hogan. The grandmother is teaching a granddaughter to make Navajo bread (which may be fried in deep fat), while her daughter and other granddaughters watch over the youngest child. The pounded dirt floor serves as the "kitchen table." The floor, partially covered with an oilcloth, also serves as the table at mealtime, and at night serves as a bed when covered with sheepskins. The bed in the background is the main article of furniture. Ventilation in this one-room, windowless dwelling is provided by the cracks around the door and by a central 2- by 2-foot smoke hole in the roof, toward which the chimney of the gasoline-drum stove is directed. The interior diameter of the dwelling is approximately 20 feet. [Milton Snow, Bureau of Indian Affairs, Window Rock, Ariz.]

An infant securely laced on a cradleboard. This practice has certain definite advantages, including ease of transportation and management when the mother and child go away from home—for example, to the trading post. The position in which the infant is placed, however, with the legs fully extended, is one that would aggravate, and perhaps even favor the occurrence of "congenital" dislocation of the hip. Where there is any tendency to hip dislocation, a froglike position, with the thighs separated, helps keep the thigh bone in its pelvic socket. To lace babies on a cradleboard in this position would obviously require modification of a long-established cultural pattern. [American Museum of Natural History]

cent) is almost twice the higher of the two rates (2.25 and 2.3) that form the present basis for government planning (*5*). Both the Manyfarms data and the official data recorded for the Navajo area as a whole show a year-to-year consistency.

The question immediately arises as to whether this difference between 36.3 and 49.6 live births per 1000 merely indicates that the 800-square-mile area at Manyfarms is not a representative sample of the much larger total Navajo area. In a sense, no arbitrarily selected region of a larger area can be truly representative of the area as a whole. What can be said about the Manyfarms area, however, is that in its chief socioeconomic characteristics it seems in no way atypical, and that in the opinion of long-time students of the Navajo scene it is not atypical. In this community of approximately 2000 persons, the net gain in population (excess of births over deaths) in a three-year period was 239 persons. This represents a population expansion of "explosive" proportions.

Another finding in this general study of the community was that it was necessary to devise a wholly new system for such a mundane operation as medical record-keeping in order to fit the pattern of the society. It is not always realized that, as modern medicine was developed within the European culture, all medical record systems the world over are essentially the same. They are based on the "facts of life" of Western society and are simply "imposed" on everyone else. With the Navajo it was found that recording of kinship relationships was of considerable importance because two persons within the same immediate family may have different names. In order to recognize that two patients with a communicable disease seen at different times at the field clinic were in fact living together in the same hogan or camp, it was necessary to organize all of the individual charts of the patients by clan and by the composition of the extended and immediate (that is, nuclear) families. This was also of importance because, especially in the past, the Navajos, like many other peoples living in tribal societies throughout the world, have tended to pay little attention to the "Western" naming systems and have continued to depend on kin and clan designations. Consequently, an individual may be recorded by several completely different names in any set of records.

Defining the Pattern of Disease

The second general study merely represents the medical aspects of the first study and has to do with defining the pattern of disease in the community. A systematic attempt was made to obtain detailed and complete physical examinations and appropriate labora-

Filling the camp water barrel by hose from a protected spring. The water may have to be hauled from 2 to 10 miles to the individual homes. The water is uncontaminated at its source but may easily become contaminated by necessary handling and the use of a communal dipper in the hogan. An extensive community program has been started, with tribal funds, to erect structures to protect the springs, such as that seen here, and to restore "sanded" wells. The unbroken colt is simply accompanying its mother while she works and is one more feeder on the overgrazed range. [James Bosch, Window Rock, Ariz.]

tory studies on every member of the community with whom the staff had any medical relationships.

The disease pattern found in the first 1600 persons examined was exactly what one would have expected from the nature of the society. Approximately three-quarters of the disease (76 percent) was either microbial disease or the preventable consequences of microbial disease (Table 1). An example of the latter is the permanent impairment of hearing that may result from an untreated streptococcal infection of the inner ear. Only two components of the disease pattern would seem exotic to a physician trained in the United States: the presence of trachoma and the extraordinarily high prevalence of "congenital" dislocation of the hip. Both of these diseases have long been recognized as prevalent among the Navajo (*9*).

The prevalence of tuberculosis was found to be high, but the incidence (the number of new infections per unit of time) has fallen substantially during the three-year period. In 1957 an intensive roentgenographic and tuberculin survey was made of one half of the population in the project area (in Manyfarms but not in Rough Rock). The prevalence of tuberculosis of all forms was 9.0 percent. Pulmonary tuberculosis, not including primary tuberculosis, was present in 7.0 percent of the approximately one thousand people. In 2.1 percent of the group, the pulmonary lesions were active or presumably active. Evidence that the incidence of tuberculous infection is falling was obtained from the steady fall in positive cutaneous reactions to tuberculin among the school children, almost all of whom were between five and ten years of age. In May 1956 the prevalence of individuals who reacted positively to tuberculin was 33.3 percent among 168 children (*10*). In October 1956 it was 29.4 percent, and in October 1957 the figure was 26.4 percent. A much more dramatic indication of what is going on is provided by the prevalence of positive tuberculin reactors among the 49 five-year-olds who formed the "beginners" class in the fall of 1958. Of the 49, only eight (16.3 percent) reacted positively to tuberculin, and in all but two instances the fact that the child did react positively was already known.

It is believed that this impressive fall may be in part a consequence of the Manyfarms-Rough Rock chemotherapy and chemoprophylaxis program but that it is in greater part the result of two innovations made in 1952. These were the Navajo-Cornell studies in tuberculosis chemotherapy at Tuba City and Fort Defiance and the off-reservation sanatorium program organized through the Fort Defiance facility by the Bureau of Indian Affairs (*11*). Certain of the problems involved in the ambulatory chemotherapy program are considered below, in the presentation of the segmental programs.

Respiratory disease caused by microbes other than *Mycobacterium tuberculosis* was also found to be common. Most of these respiratory infections are either definitely or presumably viral in origin. They consist of the familiar influenza-like illnesses, the respiratory complications of measles and chicken pox, and the numerous forms of "colds and bronchitis" that may afflict adults but are especially prevalent among young children. As for the *occurrence* of these illnesses, the situation among the Navajo is not particularly different from that elsewhere in the United States. Wherever infants and children are raised, families go through periods in which there seems to be simply one respiratory infection after another. The difference in the situation in an economically underdeveloped area such as the Navajo reservation lies not in the occurrence of these illnesses but in the fact that preventable serious secondary complications are much more likely to occur.

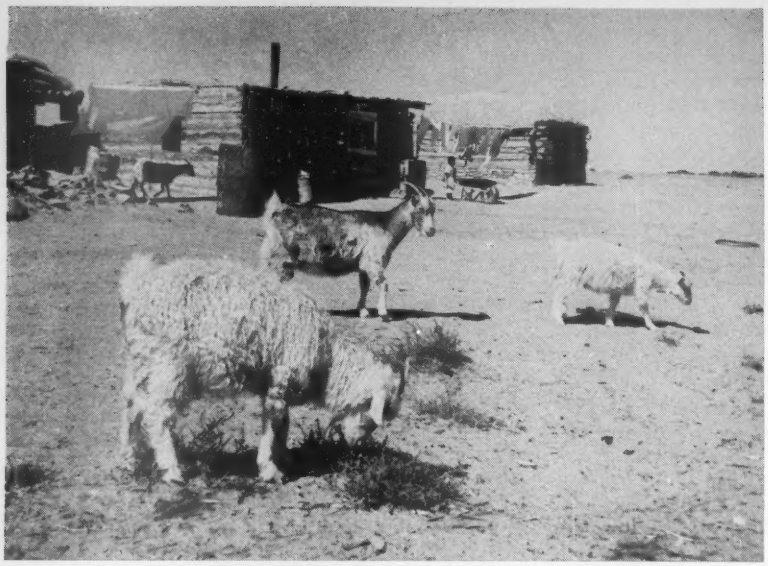
Table 1. Pattern of disease in the first 1600 persons examined in three years at Manyfarms.

Diagnosis	Percentage of total disease
Almost entirely microbial (76.3%)	
Respiratory diseases (pneumonia, influenza, and tuberculosis)	26.8
Other microbial diseases (exclusive of tuberculosis and infant diarrhea)	19.0
Sensory organs and nervous system (principally meningitis, deafness, and eye diseases, all resulting from infection)	15.5
Diseases of digestive system (principally infant diarrhea and gallbladder disease)	8.6
Disease of skin (principally infection)	6.4
Anemia, congenital hip disease, accidents (11.3%)	
Accidents	5.1
Anemia and other blood disorders	3.4
Diseases of bone (includes congenital disease of hip)	2.8
Diseases common in U.S. society (4.0%)	
Diseases of circulatory system (includes diseases of heart and vessels, principally rheumatic fever)	2.2
Allergic and endocrine and metabolic diseases (includes asthma and hyperthyroidism)	1.1
Cancer	0.2
Mental diseases	0.5
Miscellaneous (8.4%)	
Pregnancy, genitourinary diseases, congenital malformations, and so on	8.4
Total	100.0

Secondary Complications Are Serious

For example, it is well recognized that measles is generally not too serious an illness in early life, in contrast to the serious nature of the disease among adults. Yet in the late winter of 1957–1958, measles was widely prevalent in the Manyfarms-Rough Rock area, and 130 children of preschool age were seen. In approximately one-half of these children a pneumonia developed, and the pneumonia was of a type not readily controllable by present-day antimicrobial drugs. Although precise data on this point from elsewhere in the United States are now difficult to obtain, consultation with a number of eminent pediatricians revealed agreement that this was a considerably higher incidence of postmeasles pneumonia than they ordinarily found in the cities of the United States. The point was made, however, that in the first quarter of this century it was part of the medical folklore that whereas measles was generally mild, with a low incidence of pneumonia in "middle class" urban dwellers, the disease was considerably more severe, with a higher incidence of pneumonia, in slum dwellers. In effect, therefore, a viral disease widely prevalent in our society and virtually inescapable in youth is not too serious under present-day general living conditions of the United States but becomes a considerably more serious medical problem in young children living in the hogans. It should be noted that there is no evidence at all that the measles per se is any more virulent among the Indian than among the non-Indian population. Indeed, despite the high incidence of pneumonia in this 1958 epidemic, no deaths occurred among the 130 children.

Another example of disease common in non-Indian society that is more serious when it occurs among the Navajo is streptococcal infections. These are the infections that produce sore throats and that, in children, sometimes involve the ear. With modern medical care in the non-Indian United States, serious ear complications



A camp with a six-sided hogan and a rectangular slab cabin, a combination seen not infrequently in localities far from the supply of heavy logs. An apparent "improvement," the slab cabin actually is less desirable than a hogan. The cabin has a pine plank floor which, with knotholes and shrinkage, becomes less easy to keep clean than a hardened earthen floor. The cabin windows cannot be opened, and the chimney pipe is made to fit snugly; this makes a considerably warmer but a far less well ventilated room than that of the hogan, with its air intake under the door and its smoke hole in the roof. The camp water supply is stored in the gasoline drum at the corner of the cabin. A few goats may serve a useful purpose as "forage leaders" for the sheep and as an alternative source of meat. They are only a minor source of milk, however, and despite intensive efforts by government conservationists, they are frequently allowed to multiply and surpass the sheep in competition for food on the overgrazed range. [American Museum of Natural History]

of this common infection have been reduced to a negligible level. With the Navajo, however, inflammation of the middle ear of infants and children is commonplace and, indeed, is an important cause of deafness.

As a part of the Manyfarms study, an examination of hearing loss in some 270 school children aged six to ten in the project area was made. It was found that 16 percent of this group of children showed some significant loss in hearing. When a partial loss of hearing is added to the problem of attempting to receive an education in an alien language, the implications of these streptococcal infections are very great.

The same viral respiratory infections that attack the Navajo children in some cases attack the adults, and here, too, serious complication may result. For example, various potentially serious forms of nonviral pneumonia and meningitis may develop, and to a considerable extent the occurrence of these illnesses is facilitated by a preceding viral respiratory infection. In the case of the adults, however, the relatively few serious complications that arise could be readily managed in the hospitals, as they are in the United States in general, provided it is possible to get the Navajo patient to the hospital in proper time.

Demography in the field. The recent birth of a baby in this earthen-floored hogan is recorded by a Manyfarms Health Visitor as part of a routine visit. On the right may be seen the legs of a sewing machine which is covered by a manufactured blanket similar to the one hanging on the wall. Navajo women customarily wear these blankets as shawls while concentrating in their own weaving on the creation of rugs for sale. [American Museum of Natural History]

Infant Diarrhea

Diarrheal disease, likewise, is not really a problem among the Navajo adults or school children, despite the fact that the home sanitary practices with respect to drinking water, food preparation, and the disposal of feces are relatively unsatisfactory. Yet diarrheal disease is an exceedingly important problem among the infants and preschool children.

A total of 506 diarrheal episodes were observed in the clinic in a 27-month period at Manyfarms. Of the 506 episodes, 484 were observed by a physician, and 22 were not. In 23 cases it was necessary to send the

patient to the hospital. The age distribution of these 506 diarrheal episodes was quite sharp, with 75 percent of the illnesses occurring in infants or in preschool children. From the epidemiologic pattern of this illness in the Manyfarms studies, and from recent studies in virology, the suspicion is growing that the major portion of this diarrheal illness represents a viral or a combined viral-bacterial infection.

The pattern of illness fits this concept extremely well, and it appears that the infection is something that first occurs soon after the early months of life, at a time when (i) breast feedings are first supplemented with other food; (ii) the child starts crawling around on its own; and (iii) the effects of any immunity that might have been transmitted by the mother at birth would have begun to wear off. This suggests that when sanitary conditions are poor the infection is probably universal, and that a significant immunity to it develops from infection in infancy or early childhood. In most circumstances the disease is not particularly severe, but if the child remains untreated the disease may progress, and it is not infrequently fatal. The emphasis on this entity of infant diarrhea does not mean that isolated outbreaks of other forms of diarrhea in all age groups do not occur as a result of lapses in sanitation. In general, however, such outbreaks are clearly bacterial in origin, are confined to only one or two persons in a single camp, and do not represent numerically the serious health problem presented by the diarrheal disease of infants and young children.

Trachoma

Trachoma in an active stage was found to be present in 2.9 percent of the Manyfarms-Rough Rock school children less than ten years of age. This prevalence of active disease among the children was considerably less than was found at about the same time among adolescents (14 to 16 years of age) assembled from various parts of the reservation at a school for special training in Utah. In 1957 and 1958, at the fall opening of this school, the prevalence of active trachoma was 15.8 and 19.6 percent, repectively. It is evident that these considerable differences in prevalence are not explainable by differences in diagnostic criteria, for an appropriately chosen sample of the Manyfarms-Rough Rock community was reexamined in early 1959 by the same consultants (*12*) who had made the examinations in Utah, and the 2.9 percent prevalence of active trachoma among the young school children at Manyfarms was confirmed. The possibility that Manyfarms was in some way atypical with respect to trachoma seems unlikely in view of the fact that the prevalence of *inactive* trachoma found there was 16.8 percent, whereas more than 40 percent of persons more than 25 years of age showed evidences of previous disease.

It is generally accepted that the "natural" pathway for the spread of trachoma is from mother to infant. In the present situation, however, it appears that some additional factor is operating and that it favors a considerable spreading of the disease among children more than ten years of age. A factor that could operate in this way would be a lapse in accepted practices of sanitation in the reservation boarding schools.

In actuality, such lapses are known to have occurred due to water shortages or the use of communal towels, and at least two localized epidemics of trachoma have recently been observed soon after the children started living together, at the beginning of the school year. It is believed, therefore, that the situation described for trachoma represents merely one more example of the phenomenon familiar in social development, wherein a particular step from Arcadia to urban-type living may upset the balance between a people and its diseases.

Nonmicrobial Diseases

Of the nonmicrobial diseases, cholelithiasis was relatively common, with 45 instances among the 1600 persons of all ages who were examined. Neoplastic disease was quite rare, presumably not because of ethnic factors but because of the predominant youth of the population and its relative lack of exposure to such environmental factors as cigarette smoking and atmospheric pollution. Certain diseases relatively prominent in non-Indian society in the United States, such as Graves' disease (hyperthyroidism), paralytic poliomyelitis, asthma, peptic ulcer, and hypertension, were either quite rare or were not encountered at all.

References and Notes

1. B. Paul, *Health, Culture, and Community* (Russell Sage Foundation, New York, 1955); G. Foster, *Problems in Intercultural Health Programs* (Social Science Research Council, New York, 1958).
2. J. Adair, K. Deuschle, W. McDermott, *Ann. Am. Acad. Polit. Social Sci.* **311**, 80 (1957).
3. The project has received substantial support from the Division of Indian Health and, by research grant (RG-5209), from the Division of General Medical Sciences, National Institutes of Health, U.S. Public Health Service. The project is also supported in part by grants from the Russell Sage Foundation and the Max C. Fleischmann Foundation. Generous gifts of valuable commodities or equipment have been made by firms in private industry, including the Hyland Laboratories (Los Angeles), Chas. Pfizer and Company (Brooklyn), the E. R. Squibb Division of Olin-Mathieson (New York), and the Santa Fe Railroad.
4. A. Leighton and D. Leighton, *The Navajo Door* (Harvard Univ. Press, Cambridge, 1944).
5. R. W. Young, Ed., "The Navajo Yearbook," *Rept. No. 6 of Navajo Agency, Window Rock, Arizona* (1957).
6. Several more roads were paved during 1959.
7. The "Chapter" is a loosely defined rudimentary form of "local" tribal government.
8. In 1957 the highest fertility rate in New York City was among non-whites and was 117.3.
9. L. Merriam, *The Problem of Indian Administration* (Johns Hopkins Press, Baltimore, 1928).
10. In 1954, the prevalence, among U.S. Navy recruits (whites and non-whites), of individuals who reacted positively to tuberculin was 4.6 percent. See G. J. Drolet and A. M. Lowell, *Am. Rev. Tuberc. Pulmonary Diseases* **72**, 419 (1955).
11. K. Deuschle, *Am. Rev. Respirat. Diseases* **80**, 200 (1959).
12. The consultants were C. Dawson, senior investigator of the Epidemic Intelligence Service, U.S. Public Health Service, and representatives of the Hooper Foundation, University of California Medical School, San Francisco.

General Characteristics of Vavilov-Cherenkov Radiation

The theory of radiation from systems moving with superlight velocities has uses in plasma physics.

I. E. Tamm

The mechanism of radiation of light by a system moving with superlight velocity—that is, velocity in excess of the phase velocity of light in the medium—is a very simple one and is common to the radiation at corresponding conditions of all kinds of waves, electromagnetic as well as sound waves, waves on the surface of water, and so forth.

Consider a system which in principle is able to emit the radiation in question—for example, an electrically charged particle in the case of light, or a projectile or an airplane in the case of sound. As long as the velocity of this system as a whole is smaller than the velocity of propagation of waves in the surrounding medium, the radiation can be produced only by some oscillatory motion of the system or of some of its parts—for example, by the oscillation of an electron in an atom or by the revolutions of the propellers of an airplane. The frequency of the radiation emitted is evidently determined by the frequency of the oscillations in question. To be more exact, for the radiation to be possible the motion has not necessarily to be a periodic one, but it has to be non-uniform (*1*) (that is, its velocity should not be constant in time).

But when the velocity of the system becomes greater than that of the waves in question, quite a new mechanism of radiation is involved, by means of which even systems possessing constant velocity do radiate. Let $c'(\omega)$ denote the velocity of propagation in the surrounding medium of waves possessing the frequency ω. Then as a rule the radiation of a system moving in the medium with a constant velocity v embraces all the frequencies that satisfy the fundamental condition

$$v > c'(\omega) \tag{1}$$

This radiation is characteristically a very directional one—waves of a given frequency ω are emitted only at a definite angle θ to the direction of motion of the system, this angle being determined by the relation

$$\cos \theta = c'(\omega)/v \tag{2}$$

Derivation of Fundamental Relations

To prove these fundamental relations one has only to take account of the fact that, at all velocities, whether small or large, the field of a uniformly moving system must be stationary with respect to the system. If the system radiates, it means that in its field at least one free wave is present [a free wave of a frequency ω is by definition propagated in the medium with the characteristic phase velocity $c'(\omega)$ to any distance, however far from the source of the wave].

Let O and O' (Fig. 1) be the positions of the uniformly moving system at two consecutive moments $t = 0$ and $t = \tau$. The phase of the wave radiated by the system must be stationary with respect to the system. It means that if AO is the front of the wave (*2*) which at the moment $t = 0$ passes through the system at O, then this front, being propagated in the medium with the velocity $c'(\omega)$, will permanently keep up with the system and in particular will at the moment $t = \tau$ occupy such a position AO, as to pass through O. Now the direction $\mathbf{n}$ of propagation of a free wave is perpendicular to its front, and therefore OCO' is a right triangle, and we easily obtain from it the fundamental relation (Eq. 2). Since the value of a cosine cannot exceed unity, Eq. 1 follows directly from Eq. 2.

All these general properties of the radiation in question were for a very long time well known in aerodynamics. The air waves emitted at supersonic velocities are called Mach waves. The emission of these waves sets in when the velocity of a projectile or an airplane begins to exceed the velocity of sound in air. Emitting waves means losing energy, and these losses are so large that they constitute the main source of resistance to the flight of a supersonic airplane. That is why, in order to cross the sound barrier—that is, to achieve supersonic velocities—in aviation, it was necessary to increase very substantially the power of the engines of the airplane.

"Singing Electrons"

We perceive the Mach waves radiated by a projectile as its familiar hissing or roaring. That is why, having understood the quite similar mechanism of the Vavilov-Cherenkov radiation of light by fast electrons, we have nicknamed it "the singing electrons." I should perhaps explain that we in the U.S.S.R. use the name "Vavilov-Cherenkov radiation" instead of just "Cherenkov radiation" in order to emphasize the decisive role of the late S. Vavilov in the discovery of this radiation.

You see that the mechanism of this radiation is extremely simple. The phenomenon could have been easily predicted on the basis of classical electrodynamics many decades before its actual discovery. Why, then, was the discovery so much delayed? I think that we have here an instructive example of a situation not uncommon in science, the progress of which is often hampered by an uncritical application of inherently sound physical principles to phenomena lying outside the range of validity of these principles.

For many decades all young physicists were taught that light (and electromagnetic waves in general) can be produced only by *nonuniform* motions of electric charges. When proving this theorem one has—whether explicitly or implicitly—to make use of the fact that superlight velocities are forbidden by the theory of relativity: according

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to this theory no material body can ever attain the velocity of light. Still, for a very long time the theorem was considered to have unrestricted validity.

So much so, that I. Frank and I, even after we had worked out a mathematically correct theory of Vavilov-Cherenkov radiation (*3*) tried in some at present incomprehensible way to reconcile it with the maxim about the indispensability of acceleration of charges. And only on the very next day after our first talk on our theory in the Colloquium of our Institute, we perceived the simple truth: the limiting velocity for material bodies is the velocity of light in a vacuum (denoted by c), whereas a charge moving *in a medium* with a constant velocity v, will radiate under the condition $v > c'(\omega)$, the quantity $c'(\omega)$ depending on the properties of the medium. If $c'(\omega) < c$, then this condition may very well be realized without violating the theory of relativity ($c' < v < c$).

Just before our theory was published we discovered that A. Sommerfeld (*4*) as long ago as 1904 published a paper dealing with the field of an electron possessing a constant velocity greater than that of light; he calculated the resistance to such motion due to the radiation emitted by the electron. But Sommerfeld considered only the motion of an electron in a vacuum. A year later the theory of relativity came into existence, and the motion considered by Sommerfeld was proved to be impossible. Sommerfeld's paper was completely forgotten and for the first time in many years was referred to in our paper of the year 1937 (*5*).

New Approach

Let us return now to the general characteristics of radiation emitted at superlight velocities. In addition to those already indicated, a new and very peculiar one was described by I. Frank (*6*) in 1943 and V. Ginzburg and I. Frank (*7*) in 1947.

Suppose that a system A, moving with a constant velocity v, radiates an amount of energy ε in a direction characterized by a unit vector $\mathbf{n}$. The balance of energy gives the relation

$$\varepsilon + \Delta T + \Delta U = 0 \qquad (3)$$

where ΔT and ΔU denote, respectively, the increase, caused by the radiation, of the kinetic energy T of the translational motion of system A and of the energy U of its internal degrees of freedom. On the other hand, if the radiated energy ε is propagated in the medium with velocity c' in a definite direction $\mathbf{n}$, it necessarily possesses a momentum (*8*) ε/c', directed along $\mathbf{n}$. Therefore the conservation of momentum leads to the vector equation

$$(\varepsilon/c')\mathbf{n} + \Delta\mathbf{p} = 0 \qquad (4)$$

where $\mathbf{p}$ is the momentum of system A. If the increase $\Delta\mathbf{p}$ of $\mathbf{p}$ is small in relation to $\mathbf{p}$, then, according to a general rule,

$$\mathbf{v} \cdot \Delta\mathbf{p} = \Delta T \qquad (5)$$

Combining these simple and general relations, one gets

$$\Delta U = -\varepsilon\,[1 - (v \cos\theta/c')] \qquad (6)$$

where θ is the angle between $\mathbf{v}$ and $\mathbf{n}$.

If the system A possesses no internal degrees of freedom (for example, a point charge), then $\Delta U = 0$, and Eq. 6 reduces to the already discussed Eq. 2. Thus we have obtained this fundamental equation once again, but by a new way of reasoning. On the other hand, if the system possesses internal (say, oscillatory) degrees of freedom, and if its velocity is small ($v << c'$), then, as usual, the internal energy U of the system decreases by an amount equal to the amount of energy radiated.

But at superlight velocities ($v > c'$) the value of the quantity in the bracket in Eq. 6 may become negative, so that radiation of energy by the system may be accompanied by a *positive* increase ($\Delta U > 0$) of its internal energy U—for example, an atom, being originally in the stable state, radiates light and at the same time becomes excited. In such a case the energy both of the radiation and of the excitation is evidently borrowed from the kinetic energy T—that is, the self-excitation of a system is accompanied by a corresponding slowing down of the motion of this system as a whole.

The relation shown by Eq. 6 emerged in discussion of optical problems, but it is of a quite general nature and it may turn out to be useful to apply it in aerodynamics [just as Mach's aerodynamical relations (Eqs. 1 and 2) turned out to be useful in optics].

Certainly, a correct calculation of a supersonic motion will automatically take into account everything, including the possible self-excitation of some particular modes of vibrations of a supersonic airplane. However, such calculations are necessarily extremely complicated, so that relation 6 may prove to be useful in giving an insight into the general mechanism of some of the phenomena that become possible at supersonic velocities. On the other hand, Eq. 6 takes into account only the radiative damping of oscillations, whereas in the case of mechanical vibrations of an airplane this kind of damping is under ordinary conditions quite negligible in comparison with the damping caused by the internal friction in the vibrating materials. In short, we must consider it an open question whether the phenomena indicated may be of any importance in the complicated problem of supersonic flight.

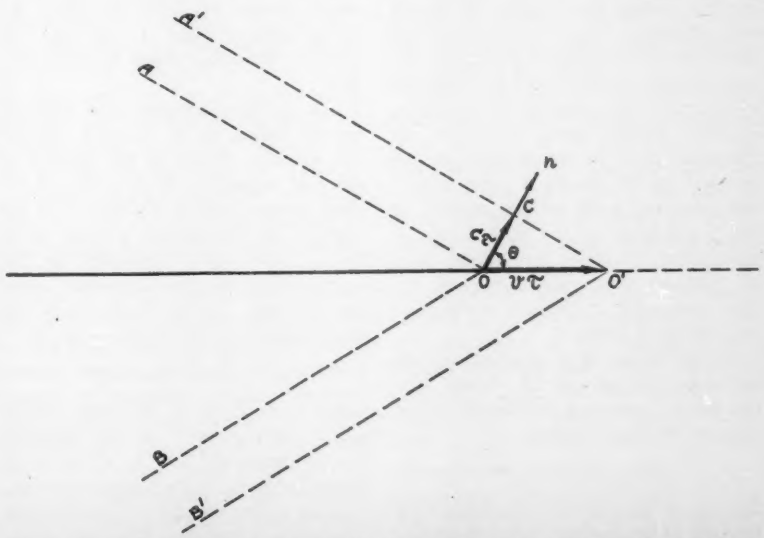


Fig. 1. Geometrical relationships involved in the emission of Vavilov-Cherenkov radiation.

Let us now consider as examples some applications of the general theory to a special field—namely, plasma physics. In a preparatory way we begin with some remarks on the mechanism of energy losses experienced by fast, charged particles traveling through matter. Vavilov-Cherenkov radiation accounts only for a part—and usually a very small part—of these losses, which are largely due to the ionization and excitation of the medium traversed by the particles. However, the mathematical treatment used by Frank and me (*3*) to calculate the radiation losses proved to be useful for the general problem also. It was extended in 1940 by Fermi (*9*) so as to cover the total energy loss of a charged particle, with the exception of the losses caused by head-on collisions of the particle with atoms of the medium. The losses of the latter kind must be calculated separately. The main difference between Fermi's work and ours is that we assumed the medium traversed by the particle to be transparent, whereas Fermi took into account not only the polarization of the medium by the electrical field of the particle, as we did, but also the absorption of electromagnetic waves in it. Fermi has shown that the screening of the field of the particle, which is caused by the polarization of the medium and which was not taken into account in previous work on this subject, very considerably reduces the energy losses of very fast particles.

We will not review here the very extensive work on the subject by which Fermi's theory was further elaborated and extended. But to obtain some insight into the underlying mechanism we will consider in some detail the processes taking place in a plasma (for example, a highly ionized gas), which for our purposes may be considered as the simplest of all media. I have myself not done any work on this subject, so that I will report on the work of others, mentioning by name the authors only of relatively new papers, without explicit references to classical works such as those by N. Bohr.

Energy losses of a charged particle traversing plasma can be divided into two parts. Imagine a cylinder of radius equal to the Debye radius

$$D = (kT/4\pi Ne^2)^{1/2}$$

the axis of the cylinder coinciding with the path of the particle. The interaction of the particle considered with plasma particles lying *inside* the cylinder must be treated microscopically; resulting energy losses will be referred to as those due to close collisons. But the interaction of the particle considered with the plasma lying *outside* the cylinder can be treated macroscopically; resulting energy losses will be designated as "coherent" ones. Under ordinary conditions losses of both kinds are of about equal importance, but in a very hot and rarefied plasma, so important in thermonuclear research, the cross section for the direct Coulomb interaction of charged particles decreases and the coherent losses eventually become preponderant.

Since the index of refraction n of a plasma is for all frequencies less than 1, and the velocity of light $c' = c/n$ in plasma greater than its velocity c in a vacuum, it may appear that the Vavilov-Cherenkov effect should be absent in plasma. But that is not the case. Firstly, only the velocity $c'(\omega)$ of transverse electromagnetic waves in a plasma exceeds *c at all frequencies,* but not so the velocities of plasma waves proper. These are longitudinal waves, in which oppositely charged plasma particles oscillate in opposite directions, the restoring force being provided by the resulting electric field. Secondly, in a magnetic plasma—that is, a plasma exposed to an external magnetic field—both kinds of waves become interconnected, so that no sharp distinction can be drawn between the transverse and the longitudinal waves. As a result the index of refraction of light varies with the directions of its propagation and polarization and in a certain range of these directions becomes greater than 1, so that the Vavilov-Cherenkov effect becomes possible.

Let us first consider the coherent energy losses of a charged particle moving in a plasma in the absence of external magnetic fields. Almost all these coherent losses are due to the excitation of longitudinal plasma waves by a mechanism equivalent to the mechanism of Vavilov-Cherenkov radiation of light. To be more exact, the phase velocity c' of plasma waves is

$$c' = [3v_T^2 + (\omega_0^2/\kappa^2)]^{1/2} \qquad (7)$$

where $\kappa = 2\pi/\lambda$ is the wave vector; $\omega_0 = (4\pi Ne^2/m)^{1/2}$ is the so-called plasma frequency; and v_T is the mean thermal velocity of the plasma electrons. As long as the velocity v of the particle considered is less than $3^{1/2}v_T$, the necessary condition $v > c'$ for the emission of plasma waves cannot be satisfied; under this condition practically all energy losses experienced by the particle are due to close collisions. But when v exceeds $3^{1/2}v_T$ the condition $v > c'$ is satisfied for a certain range of wavelengths $\lambda = 2\pi/\kappa$, and the coherent losses take place (*10*).

Allow me now to make a digression and to turn your attention from plasma to solid metals. At high enough frequencies the valence electrons in a metal can be considered as free and thus as forming together with the atom-cores a kind of plasma. The plasma frequency ω_0 is proportional to the square root of the density of plasma electrons. Since this density is in a metal far greater than it is in an ordinary plasma, the frequency of plasma waves in metals is rather high, of the order of $\hbar\omega \sim 10$ ev.

In analogy to the case of an ordinary plasma, we have to expect that a fast electron traversing a metal foil will experience, besides other kinds of energy losses, also losses due to the excitation of plasma waves by the mechanism just described. Now that is in fact the case. It is well known that fast electrons traversing a thin metal foil often experience in it large discrete energy losses of the order of 10 ev. I refer you to a comprehensive article by D. Pines (*11*) where it is shown that an elementary theory of the plasma excitation in a metal by a fast, charged particle, very similar to the theory outlined above for the case of an ordinary plasma, fits the experimental facts relating to discrete energy losses in metals so well, that, in words of the author: "What puzzles exist have to do with why the agreement is so good, rather than with explaining existing disagreements."

Turning again to the ordinary plasma, I would like to emphasize that the absorption of plasma waves in the plasma itself is conditioned by a reverse Vavilov-Cherenkov effect.

The necessary condition for a marked absorption of waves is the existence of a resonance between the frequency of the wave and a frequency of the absorbing system—for example, an atom. Thus a free electron, which in distinction to a bound electron possesses no eigen-frequency, performs in the field of wave periodic oscillations, alternatively acquiring and losing kinetic energy and thus producing no substantial absorption. But there exists also another nonresonant mechanism of absorption.

If the velocity v of a free electron is greater than that of the wave ($v > c'$),

then the projection of the velocity of the electron in the direction of propagation of the wave v cos θ may become equal to the velocity of the wave:

$$v \cos \theta \simeq c' \qquad (8)$$

In this case the electron rides, so to speak, on the crest of the wave, being exposed to a force whose direction does not alter in time, and thus it continually absorbs energy from the wave until its velocity increases so much that the electron drops out of phase with the wave.

Such is the mechanism of absorption of plasma waves (*12*); the condition shown by Eq. 7, which sorts out those plasma electrons that take part in the process of absorption, is identical with the fundamental condition (Eq. 2) for radiation (*13*).

The damping coefficient γ of plasma waves was first calculated by Landau (*14*) in 1946. Changing the notations used by Landau, one can present the exponential term in Landau's formulation in the following form

$$\gamma \sim e^{-mu^2/2kT} \qquad (9)$$

where $u = \omega_0/\kappa$. In the range of validity of Landau's formula, ω_0/κ equals the velocity c' of the wave in question.

Therefore, according to Eq. 9, the damping of a plasma wave is proportional to the density of plasma electrons, possessing, according to Maxwell's law, a velocity u, equal to the velocity of the wave. This is in exact correspondence to the mechanism of absorption just indicated.

In a recent paper on the mechanism of the sporadic solar radioemission, Ginzburg and Zhelesniakov (*15*) applied and extended the theory outlined above to a new and very interesting domain of physics, the foundation of which was laid in Sweden by Alfvén. In particular, they have shown that the known instability of a beam of charged particles traversing plasma is, from a quantum theoretical point of view, due to the negative absorption of plasma waves by the beam of particles (the *induced* radiation of waves by the beam particles prevailing over the true absorption).

Methods of Heating

Before finishing I would like to mention one problem which plays a rather important role in the present fascinating world-wide effort to harness thermonuclear reactions for peaceful uses—the problem of how to heat the plasma. The first stages of heating can be easily achieved by exciting an electric current in the plasma. However, the cross section for Coulomb collisions of charged particles decreases inversely as the fourth power of their relative velocities, and in a hot and rarefied plasma these collisions become so rare as to become negligible. Evidently heating by electric currents becomes therewith impracticable: only a very small part of the energy of the ordered motion of plasma electrons, excited by an external field, is under these conditions converted into Joule heat.

Many different methods to achieve further heating of the plasma are now being discussed—for example, the so-called magnetic pumping. I wish to make some remarks on only two of such methods, intimately connected with our subject.

First, the heating by a beam of fast, charged particles, injected into plasma from outside, is in principle feasible even if the plasma is hot and rarefied. Although in such a plasma energy losses of fast particles due to close collisions become negligible, coherent energy losses, described earlier, are independent of the collision cross section and become all-important.

It is necessary to stress in this connection two points. First, the heating can in principle be achieved by a beam of fast, charged particles traveling, not in the plasma itself, but outside of it, parallel to its surface. In fact, as we have seen, coherent energy losses are due to the emission of plasma waves by the fast particles. Now, those waves, the length of which is large in comparison with the distance of the beam from the surface of the plasma, will be excited by an external beam much to the same degree as by a beam traversing plasma. The possibilities offered by an external beam were first pointed out by L. Mandelstam for the case of ordinary Vavilov-Cherenkov radiation. Later Ginzburg (*16*) proposed a method of generating microradiowaves by means of fast particles traveling along the surface of an appropriate dielectric or in a tunnel bored through the dielectric.

The second point is, that if the beam consists of a succession of separate clusters of charged particles, then all the particles of each cluster will generate coherently those plasma waves, the length of which is large in comparison with the dimensions of the clusters. Therefore the intensity of these waves will be proportional not to the number of particles in a cluster, but to the square of this number. Evidently this offers the possibility of enhancing the radiation and the heating effect of a beam very considerably.

Magneto-Acoustic Waves

Let us now turn to another possible method of heating. Morozov (*17*) has calculated the excitation of so-called magneto-acoustic waves in a magnetic plasma (that is, a plasma exposed to a constant external magnetic field) by an electric ring current moving with a sufficient velocity in a direction perpendicular to the plane of the ring current. The current may move within the plasma—one can imagine a plasma ring, bearing a current, the ring being injected from outside into the plasma to be heated. Otherwise the current in question may be flowing outside the plasma on the surface of the vessel containing it, such an external current being similar to the external beam of particles discussed above.

Generation of waves by a moving current is a special case of Vavilov-Cherenkov radiation. Morozov has shown that, under certain conditions, the absorption in plasma of magneto-acoustic waves produced in this way may in principle lead to a very considerable heating of the plasma. Of course the velocity of the current must exceed the velocity of the waves in question. One of the causes of the high heating efficiency of a current is the coherence of the waves generated by its different elements. In this respect there exists an analogy between a current and a cluster of charged particles, the radiation of a current being proportional to the square of its strength.

There is another possible way of utilizing the Vavilov-Cherenkov radiation of a current. It is well known that currents excited in plasma, which in virtue of the pinch effect are usually concentrated in a thin thread, are highly unstable. Therefore, in practical applications, it is often all-important to stabilize them. If the walls of the vessel containing plasma are conducting, then a displacement of the plasma current toward the walls will induce Foucault currents in them, and these currents will tend to repel the plasma current. Methods of stabilization based on this phenomenon were independently proposed by physicists in different countries and were used in a number of thermonuclear experiments, but have proved

to be not very satisfactory. Morozov and Soloviev (*18*) have recently proposed to construct the walls of vessels containing plasma not of conducting materials but of such materials in which the velocities of propagation of electromagnetic waves in an appropriate range of frequencies are as small as possible. If a current flowing in plasma along the surface of such a wall is displaced toward this surface with a velocity exceeding the velocity of propagation in the wall of waves of a certain frequency, then these waves will be radiated by the current into the wall. The recoil force acting on the current will tend to repel it from the wall and thus to stabilize the current.

I wish to emphasize that I have no definite opinion on the possible advantages and disadvantages of methods of heating and of stabilization or on their technical feasibility. They were selected by me only as examples of possible applications of the general theory which I outlined in the beginning of this article. The applications mentioned were necessarily confined to a very limited domain of physics.

I can only hope that I have succeeded to some extent in conveying the impression that there are further possibilities for applying this theory to new and interesting physical problems, and that work done on these lines may be useful in solving these problems or at least in getting an insight into the general physical mechanism of some of the relevant phenomena.

References

1. Concerning an exception to this rule—the so-called transition radiation—see V. L. Ginzburg and I. Frank, *J. Phys. U.S.S.R.* **9**, 353 (1945).
2. The fronts of the wave are conical, owing to the cylindrical symmetry; AOB is the projection on the plane of drawing of such a cone.
3. I. Tamm and I. Frank, *Compt. rend. acad. sci. U.S.S.R.* **14**, 109 (1937).
4. A. Sommerfeld, *Göttingen Nachr.* **99**, 363 (1904).
5. A. Joffé drew our attention to Sommerfeld's paper.
6. I. Frank, *ibid.* **7**, 49 (1943).
7. V. L. Ginzburg and I. Frank, *Compt. rend. acad. sci. U.S.S.R.* **56**, 583 (1947).
8. For the case of electromagnetic radiation it was shown first by quantum-theoretical reasoning (Ginzburg) and then by means of classical electrodynamics [G. Marx and G. Györgyi, *Ann. Physik* **16**, 241 (1955)] that v/c' (c' being the phase velocity) is in fact equal to the total momentum radiated, which comprises both the momentum of the radiation proper and the momentum acquired by the medium.
9. E. Fermi, *Phys. Rev.* **57**, 485 (1940).
10. The fact that short plasma waves are very strongly absorbed in plasma itself has no influence on the phenomenon, since the condition of radiation $c'(\omega) < v$ is satisfied only for long enough plasma waves ($\lambda > D$), the damping coefficient of which is small in comparison with their frequency.
11. D. Pines, *Revs. Modern Phys.* **28**, 184 (1956).
12. In principle this mechanism of absorption was indicated as long ago as 1949 by D. Bohm and E. P. Gross [*Phys. Rev.* **75**, 1864 (1949)]. The work of these authors is intimately connected with earlier work of A. Vlasov. A detailed and very lucid mathematical treatment of this subject was presented by R. Z. Sagdeev and V. D. Shafranov at Geneva in September 1958.
13. Radiation takes place if there is, say, one electron of velocity v or a cluster of such electrons, the dimensions of the cluster being small in comparison with the length of the wave radiated. If, however, electrons of a given velocity v are distributed continuously in space, then they do not radiate, since their wave fields are destroyed by mutual interference. But they do absorb.
14. L. Landau, *Zhur. Eksptl. i Teoret. Fiz.* **16**, 574 (1946).
15. V. L. Ginzburg and V. V. Zhelesniakov, *Astron. Zhur.* **35**, 694 (1958).
16. V. L. Ginzburg, *Compt. rend. acad. sci. U.S.S.R.* **56**, 145 (1947).
17. A. Morozov, *Plasma Physics and Thermonuclear Reactions* (Moscow, 1958), vol. 4, p. 331.
18. A. Morozov and L. Soloviev, *ibid.*, p. 391.

Science in the News

Soviet Bloc and West Accept Plan for Space Research

Scientists from the Soviet bloc have agreed to cooperate with Western scientists on problems of space science within the framework of the Committee on Space Research (COSPAR). Agreement was announced on 9 January by the new president of the committee, H. C. Van Der Houlst of the Netherlands. The present arrangements followed a year of discussion by East and West about how each side should be represented on the committee. The Committee on Space Research was established in October 1958 to continue the cooperation in space studies that characterized the International Geophysical Year.

The solution to the problem of representation was to create a seven-man inner cabinet, or bureau, consisting of the president of the committee and six other members. These members, like the president, are elected to office, but with this restriction, that there must be a balance between East and West in the nationalities of the six members elected. Three members of the bureau are from the Soviet bloc (the Soviet Union, Czechoslovakia, and Poland) and three members are from Western nations (the United States, Great Britain, and France). A clause in the committee's new charter bearing on the committee's executive council indicates the power of this bureau. The clause provides that "any decision of the Executive Council must be confirmed by a vote of two-thirds of the seven elected members."

Representation on the Committee on Space Research is open to all national scientific unions and institutions that are recognized by its parent body, the International Council of Scientific Unions, and that are actively engaged in space studies. The unions designate representatives to the committee, but the presence of the seven-man bureau will serve to prevent the sudden appearance of a host of new representatives whose purpose is solely to gain a voting advantage for some country. The first International Space Science Symposium, which opened in Nice, France, on 10 January, was sponsored by the committee.

Early U.N. Talks Asked

On 8 January, in another development, the United States asked the Soviet Union to agree to arrange a meeting in the very near future of the permanent United Nations Committee on the Peaceful Uses of Outer Space. Informed observers note that the United States

may be seeking an arrangement whereby advance notice would be given by any country of its plans to launch objects into outer space.

The permanent 24-nation committee was established by the U.N. General Assembly last December after the successful completion of direct negotiations between the United States and the Soviet Union on the question of the membership of the committee. The committee is to have seven members from the Soviet bloc, 12 from the West, and five from neutral countries. The Soviet Union boycotted the temporary United Nations Outer Space Committee, which went out of existence last September, on the ground that it was controlled by a majority from the West.

The United States has also asked that an international scientific conference on problems in space research—a conference that the United Nations is scheduled to sponsor in 1960 or 1961—be held this year. The United States suggests that the conference be held in Geneva the first 2 weeks in September.

Meanwhile, President Eisenhower conceded at his news conference on 13 January that the Soviet Union has the right to use the central Pacific as a target in its projected series of missile experiments. On 7 January, the day of the President's State of the Union address, the Soviet Union announced its plans to test rockets in that region.

Societies Sponsor Visiting Foreign Scientist Programs

A special program to provide for visits of foreign scientists to U.S. research institutions will be conducted by the American Institute of Biological Sciences during 1960–61. A $50,000 National Science Foundation grant has made it possible to expand the existing AIBS Visiting Biologists Program to include distinguished biologists living outside the United States.

Oswald Tippo of Yale University, chairman of the AIBS Education Committee, said the committee undertook the new activity in the belief that small colleges as well as large centers will be interested in obtaining scientists from overseas for seminars and for speaking or teaching assignments. Initially the program will operate on a small scale, in view of logistic problems.

Requests for speakers will be accepted from any institution. A detailed itinerary for a speaker's visit must accompany each request.

There will be no geographical limitations in the selection of speakers. Those selected will receive subsistence as well as honoraria to cover the expense of travel (by air) from any country in the world. Institutions will be asked to provide on-campus subsistence as their contribution to the program.

Each official AIBS-sponsored visit will occupy 4 weeks. During this time the speaker must visit at least four institutions, spending 3 to 5 days at each. It is hoped that at the conclusion of his AIBS assignment other groups will utilize his services while he is in this country.

Requests will be received until 1 April 1960. Immediately thereafter a committee will meet to review the requests. Notification of the action taken by the committee will be sent to each institution as soon as possible.

Requests should be addressed to the Foreign Visiting Lecturers Program, American Institute of Biological Sciences, 2000 P St., NW, Washington 6, D.C.

Engineers Announce Similar Project

The Engineers Joint Council has announced that it too will conduct an NSF-supported program for visiting foreign scientists during the next 6 months. However, the visiting scientists will be chosen by the appropriate engineering society in the five specialty areas.

Enoch R. Needles, EJC president, reports that, although the program is planned primarily to aid departments of engineering that have Ph.D. programs and active research activities, "attention will also be given, when possible, to the needs and desires of institutions whose developing programs of teaching and research could be given strong impetus by such visits." The invited foreign scientists will also be given an opportunity to attend appropriate engineering society meetings and visit nonuniversity research organizations. John S. Koss, staff assistant at the Engineers Joint Council, will direct the program from council headquarters in New York.

Physicists Report on Their Program

The American Institute of Physics reports that Denys Wilkinson of the Clarendon Laboratory, Oxford, England, was the first of the distinguished physicists from other countries to take part in the Visiting Foreign Scientists Program in Physics, which is being conducted jointly by the institute and the American Association of Physics Teachers under a grant from the National Science Foundation. During November and December, Wilkinson visited Louisiana State University, Stanford University, and the University of Washington, spending approximately a week at each institution. He discussed research problems with physicists at those universities, gave lectures on his work on the structure of light nuclei and the photonuclear interaction, as well as popular lectures, and met undergraduate physics majors.

Itineraries are now being arranged for visits by other physicists, from the United Kingdom, Germany, France, and Italy, to physics departments in the United States. The average visit will last a week.

Expressions of interest by physics departments, stating preferred times and fields of physics, should be directed to the Visiting Foreign Scientists Program at AIP (335 E. 45 St., New York 17). The Visiting Foreign Scientists Program supplements the Visiting Scientists Program in Physics, under which visits by U.S. physicists to colleges, universities, and high schools are currently being arranged by AAPT and AIP under NSF grants.

International Computer Federation Formed by Eleven Nations

The International Federation of Information Processing Societies was established this month when 11 nations ratified the statutes for the organization. The new body provides for the first time a common meeting ground for computer experts from all over the world. Until now, many countries, including the United States, have had their own professional computer societies, but these groups have had no permanent, formal means of meeting and exchanging ideas.

The movement to form the federation was a direct result of the first International Conference on Information Processing, sponsored by UNESCO and held in Paris last June. As a result, a provisional bureau for the international federation was established, with Isaac L. Auerbach, president of Auerbach Electronics Corporation, Narberth, Pa., named provisional chairman. Auerbach

represents the National Joint Computer Committee of the U.S. and was U.S. consultant to UNESCO for the Paris conference. Also named to the provisional committee were A. A. Dorodnicyn of the U.S.S.R. and A. van Wijngaarden of the Netherlands, vice chairmen, and J. A. Mussard of UNESCO, secretary.

The countries whose national computer societies have ratified the statutes include Canada, Denmark, Finland, France, Germany, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom, and the United States. In addition, Belgium, Israel, and Japan are forming national computer societies to qualify for membership.

The National Joint Computer Committee, the U.S. member of the federation, is made up of representatives of the Institute of Radio Engineers, the Association for Computing Machinery, and the American Institute of Electrical Engineers.

It is expected that the first meeting of the IFIPS council, later this year, will result in plans for a second International Conference on Information Processing and for a technical exhibit, in 1963.

Implications of the Use of Space To Be Studied by Brookings

An exploratory study on the social, economic, and political implications of the use of space for peaceful and scientific purposes will be undertaken by the Brookings Institution for the National Aeronautics and Space Agency. The project, which will take a year to complete, will attempt to identify areas worthy of research, to recommend specific studies and methods of conducting them, to suggest priorities in carrying out the research, and to indicate the potential utility of the findings.

The assistance of distinguished natural scientists and social scientists will be enlisted in assessing the important social implications of space activities. The study is a step toward one of the objectives set forth in NASA's enabling legislation: "The establishment of long-term studies of the potential benefits to be gained from, the opportunities for, and the problems involved in, the utilization of aeronautical and space activities for peaceful and scientific purposes."

The project will be conducted under the general guidance of James M. Mitchell, director of the Brookings Conference Program on Public Affairs and former associate director of the National Science Foundation. Donald N. Michael, who has had broad experience in government and industry—most recently as senior research associate with Dunlap and Associates, Inc., and previously as a scientific warfare adviser for the Weapons Systems Evaluation Group, Joint Chiefs of Staff — has joined the Brookings staff to direct the study.

Decline in Undergraduate Enrollment in Engineering Colleges

Undergraduate enrollment in the nation's 234 engineering colleges and universities declined 5.4 percent last fall in the face of an all-time high in general college enrollment, according to a report prepared in the office of U.S. Commissioner of Education Lawrence G. Derthick. The number of full-time and part-time undergraduates in engineering schools last fall was 243,000 as compared with 257,000 in the fall of 1958. General college enrollment rose from 3,259,000 in the fall of 1958 to 3,402,000 in 1959—an increase of over 4 percent.

The most significant feature of the decline in undergraduate enrollment in the engineering schools is that freshmen enrollments declined for the second consecutive year. The total number of freshmen in engineering courses in the fall of 1959 was 68,000, as compared with 70,000 in the fall of 1958. This is a reduction of 3 percent. The 1958 11-percent decline in full-time freshmen engineering enrollments is largely reflected, according to the report, in a 10-percent drop in sophomore enrollments last fall. The reduction in the number of full-time engineering sophomores is from about 53,000 to about 48,000.

Full-time junior enrollments in engineering classes last fall declined 7 percent (from about 47,000 to less than 44,000), and senior full-time enrollments, about 2 percent (from over 48,000 to approximately 47,000). The 36,000 part-time engineering students are included in the total undergraduate figure cited, but not in the figures for each undergraduate level. Part-time students are not ordinarily identifiable by class level.

The number of graduate students in engineering schools in the fall of 1959 was something over 35,000 as compared with a little less than 33,000 in the fall of 1958.

Science Teachers To Meet

School science programs—from kindergarten through the 12th grade—will be the main concern of approximately 2000 teachers when they meet in Kansas City, 29 March–2 April, for the eighth annual convention of the National Science Teachers Association. The program includes two Nobel Prize winners, Linus C. Pauling and Walter H. Brattain. Association president Donald G. Decker, who is dean of Colorado State College at Greeley, will set the stage for discussions throughout the convention at the opening general session, when he will outline the problems and issues involved in teaching science today.

Current science topics will be explored in an extensive "Frontiers of Science" series of discussion sessions. Addresses by college and research scientists will focus attention on recent developments in the major fields of science. Included in the "Frontiers" program, in addition to Pauling and Brattain, will be such outstanding speakers as George B. Kistiakowsky, science adviser to President Eisenhower, and John R. Heller, director of the U.S. National Cancer Institute.

For the first time, conferences for science supervisors, consultants, and coodinators will be given NSTA sectional status when they are convened on the mornings of 29 and 30 March. The evening general session on 31 March will feature the announcement of winners in the STAR '60 awards program for science teachers. Winners are selected on the basis of entries demonstrating effective science-teaching methods. An award of $1000 and 55 others totalling $12,500 will be presented. Approximately 100 commercial exhibits of science-teaching materials, the largest number at any NSTA convention, will be displayed in the Kansas City Municipal Auditorium, where all the general convention sessions will be held. Banquet and luncheon sessions and other related meetings will be held in the two convention headquarters hotels, the Muehlebach and the Phillips.

Grants, Fellowships, and Awards

Laboratory constructions. The National Science Foundation has announced that the next closing date for the receipt of proposals for support of renovation or construction of labora-

tories for research at the graduate (doctoral) level is *1 March*. Proposals received prior to that date will be reviewed during the late spring and early summer. Disposition of approved proposals will be made during the late summer.

This program continues to require at least 50-percent participation by the institution, with funds derived from nonfederal sources. Proposals may be submitted for modernization or construction of research laboratories, including laboratory furnishings but not apparatus or equipment, in any field of the natural sciences. For the present, this program is restricted to those departments which have a current program leading to the Ph.D. degree. Support of facilities to be used primarily for instructional purposes will not be considered. It is suggested that, according to the discipline involved, preliminary inquiry be made to either the Division of Biological and Medical Sciences or the Division of Mathematical, Physical, and Engineering Sciences, National Science Foundation, Washington 25, D.C.

Space. As many as 18 Guggenheim fellowships for graduate study in 1960–61 in space flight, rockets, jet propulsion, and flight structures will be granted this spring. The graduate study will be done at the Daniel and Florence Guggenheim jet propulsion centers at Princeton University and California Institute of Technology and at the Daniel and Florence Guggenheim Institute of Flight Structures, at Columbia University. The fellowships provide tuition and a stipend ranging from $1500 to $2000, according to the stage of advancement of the student.

Fellowships are open to qualified science or engineering students who are residents of the United States or Canada, who have outstanding technical ability and qualities of leadership, and who intend to make a career of rocketry, jet propulsion, design of flight structures, or astronautics. Students graduating in physics, physical chemistry, and applied mathematics are especially invited to apply, as well as those graduating in chemical, mechanical, and aeronautical engineering.

Booklets and posters describing the fellowships have been widely distributed by the Daniel and Florence Guggenheim Foundation, 120 Broadway, New York 5, N.Y. Applicants must file applications and credentials with the university selected *by 1 March*. Successful candidates will be notified by 1 April.

News Briefs

Antarctica. Sir Vivian Fuchs, who crossed Antarctica overland last year, recently sailed from Uruguay, as head of the official 1960 British summer expedition to the continent. He will lead 27 scientists in an attempt to restore the British base at Stonington Island and relieve the scientists at five other British winter stations on the 2000-mile circuit along the periphery of Antarctica. Members of the expedition hope to take many aerial photographs in order to compile a more detailed topographical map of the region than is now available.

* * *

Columbia building. Columbia University has received $5 million from William Black, president of the Chock Full O'Nuts Corporation, for the construction of an 18-story medical research building. One floor will be used for research projects of the Parkinson's Disease Foundation, which Black founded in 1957.

* * *

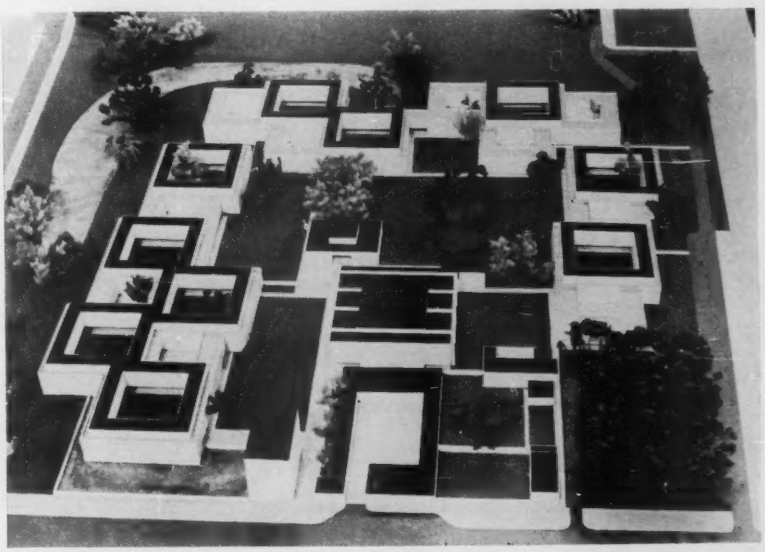
Mental health. Dedication of the Mental Research Institute building of the University of Michigan will take place at 10 A.M. on 29 January. Among the speakers will be Ralph W. Tyler, director of the Center for Advanced Study in the Behaviorial Sciences, and Detlev W. Bronk, president of the Rockefeller Institute and president of the National Academy of Sciences. During a luncheon session Ralph W. Gerard, the institute's director of laboratories, will describe the organization's program, and at an afternoon session of scientific papers, institute director James G. Miller, will discuss "Information Input Overload."

* * *

Philosophy of science. Princeton University is organizing a special program of graduate studies in the history and philosophy of science, leading to the degree of doctor of philosophy. Plans have advanced far enough to permit inviting inquiries for the year 1960–61, which may be addressed to Professor Charles C. Gillespie, Department of History, Princeton University, Princeton, N.J.

* * *

Churchill College design. A modern design has won an architectural competition for Churchill College, Cambridge University. It has been approved by the trustees who met recently under the chairmanship of Sir Winston Churchill and inspected the drawings. In May 1958 plans were announced for the establishment at Cambridge of a college of science to be named after Sir Winston. Later it was announced that Sir John Cockcroft, a leading British atomic scientist, will be its first master. The college, which will accommodate 540 students, will be the first entirely modern building of its kind at Cambridge.



Architect's working model of Churchill College which is to be added to Cambridge University. Named for Britain's wartime leader, the new college of science will occupy a 42-acre site in a suburban residential area near the university. Roughly 70 percent of the students will be studying science and technology.

Scientists in the News

Sir George Edwards, managing director of Vickers-Armstrongs, Ltd., Weybridge, England, will receive the 1959 Daniel Guggenheim Medal. Edwards was cited for introducing turboprop aircraft into international commercial service. The medal is conferred annually for advances in aeronautics.

Pennsylvania State University has announced the retirement of **Marsh W. White,** professor of physics, after 42 years on the faculty. On 31 January White will become professor emeritus.

White earned his bachelor's degree at Park College, Parkville, Mo., and his master of science from Pennsylvania State University. He received the first Ph.D. degree given by Penn State in 1926; Park College conferred an honorary doctor of science degree on him in 1958.

Anthony M.-M. Payne will become chairman of a reorganized department of epidemiology and public health at Yale University on 1 July. The British scientist is currently chief medical officer for endemo-epidemic diseases of the World Health Organization.

On 5 February, in New Orleans, the American College of Radiology will present Gold Medal awards to **H. L. Henry Garland** of San Francisco, Calif., and **Lawrence Reynolds** of Detroit, Mich.

Leland G. Cole has become vice president for research for Beckman Instruments, Fullerton, Calif. Cole, who was formerly chief chemist with Consolidated Electrodynamics Corp., will coordinate the research and development programs of Beckman's six divisions.

Milton Gross, director of the department of biochemistry at Margaret Hague Maternity Hospital, Jersey City, N.J., has received the Squibb Prize of the Pacific Coast Fertility Society for his work on cyclic changes in the biochemistry of the female reproductive tract.

William D. Taliaferro will retire as chairman of the department of microbiology and Eliakim Hastings Moore distinguished service professor at the University of Chicago on 1 July. He will be succeeded by **James W. Moulder,** an authority on chemical mechanisms relating to infectious diseases.

Leo A. Goodman, professor of statistics and sociology at the University of Chicago, is spending the current academic year at the statistical laboratory of the University of Cambridge, Cambridge, England.

Charles A. Fowler, Jr., will join the ferromagnetics research group at the Fourier Institute of the University of Grenoble, France, for the coming academic year. Fowler is chairman of the physics department at Pomona College.

Solomon E. Asch, professor of psychology at Swarthmore College, is working at the Institute for Advanced Study, Princeton, N.J., this year.

Modern Medicine has named the recipients for 1960 of the Distinguished Achievement Awards annually conferred on ten scientists for contributions to world medical progress.

Walter L. Bierring, professor emeritus of medicine, State University of Iowa, for work on medical standards.

Alfred Blalock, Johns Hopkins University, for heart and major blood-vessel surgery.

Edward A. Boyden, emeritus professor of anatomy, University of Minnesota, for renal studies.

Albert H. Coons, American Heart Association, for tagging antibodies, making possible basic cell and tissue exploration.

Irving A. Cooper, New York University, for developing surgical techniques to treat parkinsonism.

L. Emmet Holt, Jr., New York University, for studies of infant nutrition.

Elmer V. McCollum, Johns Hopkins University, for discovery of vitamins A and D.

James V. Neel, University of Michigan, for research in human genetics.

Albert B. Sabin, University of Cincinnati, for oral poliomyelitis immunization.

Nathan W. Shock, Baltimore City Hospitals, for studies of growth and aging processes.

The universities of Grenoble and Alger have conferred a doctor *honoris causa* title on **Eugene C. Wegmann,** head of the department of geology and mineralogy of the Neuchâtel University, Switzerland.

Three Oak Ridge National Laboratory biologists will do research abroad for 1 year.

In May, **Dan L. Lindsley** will transfer to the biology department of the University of São Paulo, São Paulo, Brazil.

Drew Schwartz will be at Hebrew University, Jerusalem, Israel, effective in September.

Beginning in October, **Lawton H. Smith** will be with the medical biological laboratory of the National Defense Council, at Rijswijk, Netherlands.

Georg von Békésy of the Harvard psychoacoustic laboratory has received an honorary degree of doctor of medicine from the University of Berne (Switzerland).

Christopher P. Keim, director of technical information at Oak Ridge National Laboratory, has received an honorary doctor of science degree from Nebraska Wesleyan University.

The American Institute of Electrical Engineers has named **James F. Fairman** as 1959 recipient of the Edison Medal. Fairman, senior vice president of Consolidated Edison Co. (New York), will accept the medal during the winter general meeting of the AIEE, 31 January–5 February.

Recent Deaths

Alfred Bonné, Jerusalem, Israel; 60; economist and sociologist; dean of Eliezer Kaplan School of Economics and Social Science of the Hebrew University in Jerusalem; author of works on the Middle East; 17 Dec.

Henry M. Feinblatt, Brooklyn, N.Y.; 68; endocrinologist; consultant at Kings County Hospital where he had been director of medicine from 1942 to 1952; author of *Clinical Laboratory Medicine* and *Transfusion of Blood*; 24 Dec.

Samuel H. Hamilton, Philadelphia, Pa.; 82; mining engineer and geologist; production adviser to the Atlantic Refining Company until his retirement in 1943; consultant to A. V. Smith Co. in recent years; 18 Dec.

Mary C. McKee, New London, Conn.; 74; member of the chemistry department of Connecticut College for 34 years and chairman from 1927 until retirement in 1952; 3 Sept.

Russell M. Wilder, Rochester, Minn.; 74; staff member of the Mayo Clinic for 30 years; former director of the National Institute for Arthritis and Metabolic Diseases; pioneer in the treatment of epilepsy and an expert on nutrition and diabetes; 16 Dec.

success story...

Since its introduction in the U. S. about two years ago, the interest and response of the scientific community to Metrohm equipment has been substantial. It is appropriate, therefore, to provide a more comprehensive presentation of the Metrohm "story" and the wide range of instruments and their application.

Metrohm instruments are manufactured in Herisau, Switzerland. They combine traditional Swiss craftsmanship and production control with the most recent developments in electronics. Metrohm has rejected the temptation to use certain standard electronic components in order to build the best possible equipment—quality construction without compromise. Tubes are interchangeable with those available from domestic sources, but all other parts—even the gold slide wires and potentiometers —are made by Metrohm.

METROHM

On the following pages we present some of Metrohms newest electronic measuring instruments and accessories. The complete manufacturing program includes the following:

pH-Meters	Equipment for blood pH	Gold Electrodes
Conductivity Meters	Recorders	Silver Electrodes
Redox Meters	Colorimeters	Calomel Electrodes
Titrators for Potentiometry	Unbreakable Electrodes	Titration Vessels
Magnetic Stirrers	Special Purpose Electrodes	Measuring Vessels
Polarographic Recorders	Platinum Electrodes	Piston Burettes
Coulometers	Antimony Electrodes	Glass Accessories
Spectrophotometers		

Sales and service of Metrohm equipment in the United States is through franchised distributors of scientific instruments. Complete maintenance and testing facilities are provided in Great Neck, New York by C. A. Brinkmann Company. In addition, our regional offices are available for consultation and technical assistance. Personnel concerned have been trained at the factory by Metrohm. Demonstrations without obligation can be arranged at your laboratory.

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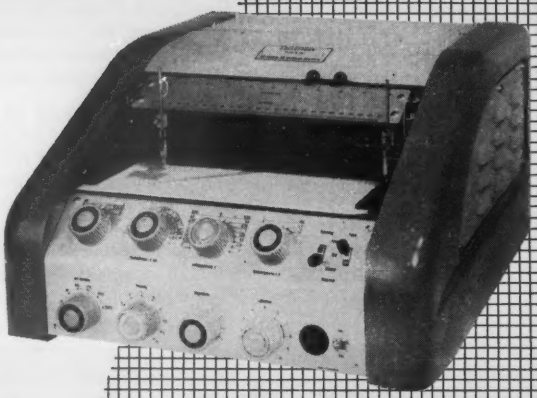
POLARECORD

The Polarecord is a fully stabilized, completely line operated instrument for polarography, amperometric or potentiometric measurements and titrations with low resistance electrodes. It can be applied to all quantitative and qualitative polarometric investigations. The radically new design features a single compact cabinet which houses the recorder and all electrical components.

The versatility of the E-261 is greater than any comparable instrument currently available. We can only suggest that you compare the following: recording by separate sheets or paper rolls—balancing speed 250 mm per second—current sensitivity from 1 x 10^{-10} to 2 x 10^{-6} amp per mm—102 polarizing ranges—paper and voltage potentiometer driven by separate synchron motors—calibrated continuously variable damping—widest compensation of diffusion and charging current—10 to 2000 mV range.



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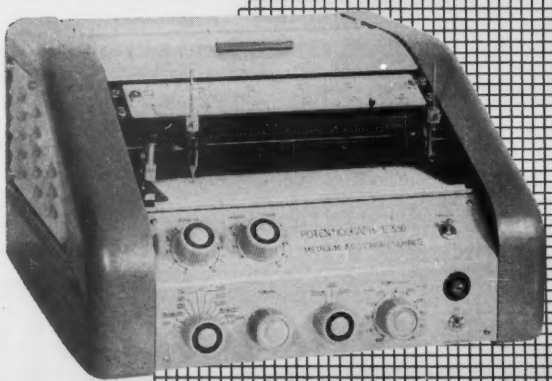
METROHM

POTENTIOGRAPH Automatic Titrator

The Potentiograph E-336 is a universal automatic recorder for all potentiometric, pH, Redox, precipitation and other (complex) titrations. Through the use of auxiliary equipment, operation can be extended to include all electrically measurable reactions such as amperometric titrations, conductometric titrations and Dead Stop titrations. There is also a built-in constant current source for titrations with polarized electrodes. In addition, the Potentiograph serves as a recording pH and mV meter.

The continuous and uniform addition of the reagent from the coupled, synchronized motor driven burette results in far more accurate determinations than can be obtained by conventional methods. If a simplified curve showing only the peak is desired, then the First Derivative may be recorded.



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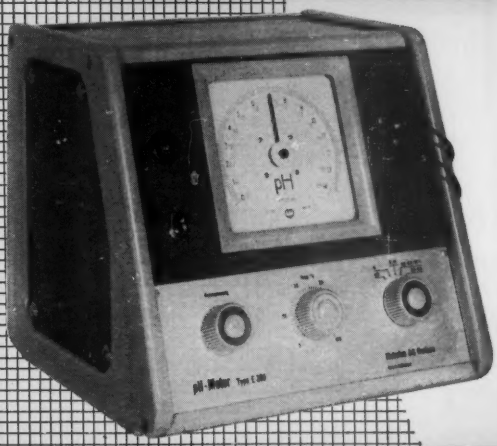
METROHM

p-H METER E-300



The Metrohm model E-300 is a pH Meter of advanced design, primarily for routine laboratory use. pH and Millivolt values are read directly on a combined scale which is 8¾" long. The unit is line operated and features an A.C. Amplifier, which reduces zero variations to such an extent that facilities for corrections are unnecessary. Reading accuracy over the full scale (0-14 pH) is 0.05 pH. Measuring accuracy is 0.1 pH. Temperature compensation from 0.100°C is provided.

In addition, there is an expanded high sensitivity scale from 5.6 to 8.4 pH, which gives direct readings of 0.01 pH. This permits the use of the E-300 for precision measurements such as blood pH determinations.

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METROHM

PRECISION COMPENSATOR E-322

The Precision Compensator E-322 is the most accurate type of pH measuring device. Errors which are inherent in any direct reading instrument can only be eliminated by using a compensating circuit. These include calibrating deviations, non-linearity of the indicating instrument and fluctuations of the amplifier, all of which do not exist in the E-322. Its accuracy, (0.005 pH), is dependent only on wire-wound resistors and the built-in standard cell.

In operation a cathode ray "magic eye" is used as zero indicator. This increases sensitivity by eliminating the bearing friction of galvanometers. Absolute zero point stability is maintained with a unique chopper-amplifier.

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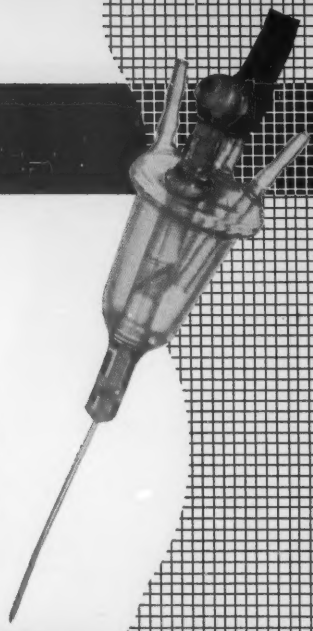
115 CUTTER MILL ROAD, GREAT NECK, N. Y.

PHILADELPHIA CLEVELAND HOUSTON MIAMI

METROHM

BLOOD and OTHER ELECTRODES



The pH value of blood varies only within a narrow range. Thus, the measurement of blood pH is unusually demanding and must be performed with high accuracy. For this work the Metrohm blood measuring chains offer some distinct advantages, including: liquid jacketed construction which permits the electrode to be connected to a circulating thermostat so that the measurement can be made almost instantaneously—separate indicating and reference electrodes to eliminate the possibility of disturbing potentials at the diaphragm—anaerobic measurements in minute quantities—plus, a handy and sturdy construction.

A complete line of regular and unbreakable glass electrodes as well as reference and metal electrodes is also available.

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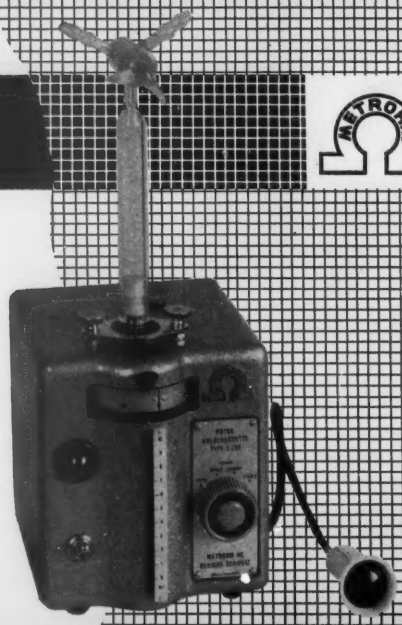
METROHM

PISTON BURETTES



The Metrohm Piston Burettte is offered in two models, hand-operated and motor driven. The principle is that of a piston replacing a liquid in a cylinder. The piston is moved by a spindle, which is turned by hand or by a motor. Filling and discharging is controlled by a three-way stopcock. Both the glass cylinder and the teflon piston may be instantly removed for cleaning.

Because of the close tolerances of the bore, the nominal accuracy of the Piston Burette is at least equal to a precision burette of standard design. Actual accuracy is superior because of the elimination of reading errors in viewing the meniscus and because no titrant can adhere to the walls of the burette.

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Book Reviews

Science Study Series. *The Birth of a New Physics.* I. B. Cohen. 200 pp. $0.95. *Waves and the Ear.* William A. van Bergeijk, John R. Pierce, and Edward E. David, Jr. 235 pp. $0.95. *The Physics of Television.* Donald Fink and David M. Lutyens. 160 pp. $0.95. *Crystals and Crystal Growing.* Alan Holden and Phylis Singer. 320 pp. $1.45. Doubleday, Garden City, N.Y., 1960 (available to secondary-school students and teachers through Wesleyan University Press, Columbus 16, Ohio).

These four volumes make up the second group of books released by the Physical Science Study Committee in their very ambitious "Science Study Series." The first five books were previously reviewed in *Science* [**130**, 616 (1959)]. Over 65 more books are planned for the next few years.

The "Science Study Series" is aimed primarily at two audiences—high-school physics students and intelligent laymen. It consequently cannot assume much mathematical sophistication or advanced knowledge of science. Nevertheless, it is intended to convey much of the excitement and flavor, as well as many of the details of modern physics to its readers. Judging from the first volumes, it is succeeding remarkably well.

The Birth of a New Physics (by I. Bernard Cohen, professor of the history of science at Harvard) traces the development of mechanics from the Greeks to Newton. To the physicist (although certainly not to the historian), this would seem to be a limited subject. However, this limitation permits Cohen to study the specific problem in more depth than is possible in the usual physics course, to show the interrelations between physical theory and other branches of knowledge, and to illustrate the way in which science constantly changes.

In the first chapters, Cohen poses the problem of explaining motion and relates the early answers of Aristotle and his successors. These approaches to physics are illustrated in Aristotelian and then Ptolemaic astronomy. Perhaps one of the major accomplishments of this section is its demonstration of the reasonableness and consistency of ancient science.

Copernicus' astronomy is then explained, with a discussion of its advantages and disadvantages. It is made clear that a choice between Copernican and Ptolemaic astronomy had to wait until Kepler's modifications and Galileo's physics. Perhaps Copernicus' most important contribution was in stimulating this later work.

This scientific revolution culminated in Newton's physics. Newton was able, among other things, to develop a mechanics incorporating and explaining the earlier work. Cohen discusses this magnificent achievement in terms of the intellectual revolution of Newton's times, and also examines it from the perspective of present-day nonclassical physics.

W. A. van Bergeijk, E. E. David, Jr., and J. R. Pierce, (Bell Telephone Laboratories) have written *Waves and the Ear.* A zoologist, an acoustical engineer, and an electronics physicist, respectively, they combine to write in the first person singular a work which touches on all these fields, and many more.

After an introductory section on sound as a means of communication, they discuss the physics of sound waves and devote two chapters to a review of the decibel system, wave phenomena in general, and sound waves in particular. In the middle section, the book shifts from pure physics into biophysics; this section discusses how sound is observed by the human being and examines the physiology of the ear, the nervous system, and the brain. The concluding sections touch upon sound production in animals and man and in high fidelity apparatus.

This book shares one characteristic with most of the works in the series. This characteristic, which is due to the selection of authors who are active in research and interested in writing well, makes the reader very aware of how much is still unknown in each field, shares with him the excitement of examining still unanswered questions, but does this without neglecting the enormous achievements that have already been made.

The Physics of Television (by Donald Fink, director of research at Philco, and David M. Lutyens, science editor of Penguin Books) is not a handbook for the repair of television sets, but, as its title indicates, is primarily concerned with the physical principles involved in television.

Like the previous book, this volume begins with a brief discussion of communication. It then gives a lucid, careful review of the physics of light and electricity. Atomic theory, solid state physics, and the wave-particle duality of light and matter are discussed, in addition to more conventional subjects such as Ohm's law and deflection of current by magnetic fields.

Given this background, the reader examines the problem of turning "light into electricity and back again." The components of a television camera, a transmitter, a receiver, and a television set are examined. The main emphasis is always put on the physical principles underlying each component and the function each component performs. Thus, circuit diagrams may be used in describing a vacuum tube oscillator, but the oscillators' over-all function is shown by block diagrams.

Alan Holden (Bell Telephone Laboratories) and Phylis Singer (Far Brook School) have collaborated in writing *Crystals and Crystal Growing.* This work is a fascinating discussion of the strange ways in which solids form, an excellent hobby book describing ways of growing crystals, and a lucid, penetrating introduction to solid state physics. It can be read on any of these levels, or, ideally, on all.

The book begins with a discussion of solids, the crystalline form, and the nature of solutions. It explains two methods of growing crystals—by sealed-jar and by evaporation—and proceeds to give "twelve recipes for growing crystals." Like a good cookbook, it always emphasizes the reasons recipes work and chooses recipes to illustrate important principles.

In the middle section of the book, the discussion covers the shapes of crystals, their symmetries, and the ar-

rangement of atoms within them. While this section demands no more formal mathematics than any other book in the series, its emphasis upon symmetry properties sets the reader thinking very mathematically. This section orients him toward the more professional study which he might someday make after mastering calculus and group theory.

The work concludes by studying cleaving, gliding, melting, the piezoelectric effect, optical phenomena, and ways of classifying crystals. It also contains excellent appendixes on relevant subjects, including some fascinating suggestions for small research projects. (I warn all future science fair judges to be prepared for a flood of crystal exhibits.)

These four books seem to me (a university physicist) to be performing their function admirably. The number of authoritative and well written science books for the layman has been increasing recently, but there is room for many more of this high quality. In addition, the books are well suited to supplement the high school physics course. (Indeed, I plan to recommend them to my college physics students.)

A student who reads Cohen's book carefully will gain valuable perspective on the way in which scientific ideas develop. He will learn much about mechanics and will be less likely than most students to insist on a final, definitive answer to a scientific question.

Waves and the Ear should prove fascinating to future students of biology and medicine. It will provide all readers with some more understanding of the ways in which various scientific disciplines overlap.

The Physics of Television should be ideal for students impatient with abstract principles and eager to dive into electronics. While satisfying their interests, the book never loses sight of the physical phenomena underlying the subject. In addition, it could be a valuable introduction to electronics for the layman or the theoretical physicist easily frightened by circuit diagrams.

Similarly, Holden and Singer's book should prove a delight to all readers. The chemist, the future solid state physicist, the rock gardener, and the ordinarily curious reader will find much that is satisfying in this book.

I look forward eagerly to more volumes in the "Science Study Series."

HOWARD LASTER

Physics Department,
University of Maryland

Man's Journey through Time. A first step in physical and cultural anthropochronology. L. S. Palmer. Philosophical Library, New York, 1959. xvi + 184 pp. Illus. $10.

The evolutionary history of *Homo sapiens*, for reasons so obvious that they need not be stated here, holds a peculiar interest and even fascination for all sorts of people. Thus it is not surprising that this area of study is subject to invasion by well-intentioned amateurs with variable qualifications. A few of these have made contributions of undoubted value. Most, however, have merely succeeded in producing literary offspring of quite doubtful scientific value. In my opinion, this book falls into the latter category.

The author, a physicist, has set for himself the commendable but formidable task of precisely measuring the rate of man's physical and cultural development through geological time. Formidable, indeed, when one considers the regrettable paucity of primate fossils and the often striking lack of agreement among competent students with respect to their precise nature and affinities. The blithe certainty frequently exhibited by L. S. Palmer is scarcely shared by professionals. Firm belief in the ability to express evolutionary changes in a precise, mathematical manner pervades this entire volume. Probably this reflects the author's background—that of a physicist—which in turn probably accounts for his biological and anthropological artlessness. For Palmer clearly fails to recognize that most of the existing fragments of man's biological and cultural history cannot be measured by other than hazy, ill-defined parameters. Estimation of evolutionary rates is, of course, a legitimate procedure, but only when the material justifies it.

Palmer concludes that man's physical development has occurred at the rate of about 1 Haldane "darwin" (that is, a rate in which the measured characteristic changes by 1/1000 in 1000 years). The validity of this entire method of approach rests squarely on the validity of the absolute time scale which the author uses. This most certainly can be disputed. Concerning the post-Villafranchian Pleistocene, it definitely is incorrect to state that "the dates for the successive cold epochs and their approximate duration have now been agreed by most authorities." This fallacious premise is sufficient to vitiate the author's major conclusion. Moreover, the fossils with which he deals undoubtedly do not represent a single, straight line of descent. Although the author clearly recognizes this, he chooses for the most part to ignore it.

His analysis of man's physical development is based exclusively on four "anatomical indices" relating only to the skull (it is so convenient to forget the rest of the skeleton; but here, it is only fair to point out, the author is not unique in his sin): (i) the nuchal area height index; (ii) the condylar position index; (iii) the cranial capacity; and (iv) the lower dental arcade convergence angle. He employs the first two of these as measures of erectness of posture; yet there is reason to believe that the placement of the occipital condyles is not an infallible clue to posture. The assumption that the fourth index is a measure of "the potentiality for articulate speech" is too artless to require refutation.

Palmer is flogging a dead horse when he depicts classic Neanderthal man as a semierect, degenerate, ape-like fellow with a prehensile great toe, who shuffled along like a chimpanzee. This ancient paleoanthropological calumny has been exposed and abandoned by serious students; but here, as in other instances, the author either is not cognizant of the pertinent literature, or he ignores it. In fact, Neanderthal man obviously is Palmer's *bête noire*. Hence Neanderthal's remarkably large brain poses a difficult problem. Quite unable to explain the occurrence of such a large cranial capacity in such a stooped, apelike creature, the author can only suggest naively that "during the last interglacial period man's skull was expanded by the internal pressure of the cerebro-spinal fluid." Quite a *deus ex machina*, indeed!

A few other examples of anthropological absurdities may be briefly noted. Rhodesian man is another uncomfortable fellow who "may well be an example of prehistoric acromegaly leading to gerontomorphism"; presumably this is a misinterpretation of some observations made by Sir Arthur Keith. Palmer's discussion of the evolution of articulate speech is flavored with clairvoyance. Mandibular morphology "strongly suggests" that the australopithecines "might have been able to speak"; and it is deduced, apparently from the temporal lobes of his brain, that "it is doubtful whether Rhodesian

man could speak." Finally, the gradient of the "lower dental arcade convergence angle" graph leads to the inference that "it may be anticipated that man's ability to speak may be appreciably increased in the near future." The author seriously considers Klaatsch's theory of polygenesis, which postulates that modern men were derived as three separate groups from three different anthropoid stocks, each of which also gave rise to one of the existing great apes. This theory, at best a historical curiosity, possibly is a foundation of the author's insinuation that the Australian aborigine is an inferior sort of *Homo*, and that the European white man is the undoubted pinnacle of all evolution.

The measurement of man's cultural development is assessed by three "quantitative" factors: (i) variation in the number of materials at man's disposal; (ii) variation in the number of his occupations; and (iii) variation in his speed of movement by mechanical means. The author's approach is based on a belief that it is possible to effect a "cultural 'grading' of man-made objects" by a point system. Even if one ignores the incompleteness of the archeological record, the validity of this *modus operandi* seems exceedingly doubtful, at best.

WILLIAM L. STRAUS, JR.
Department of Anatomy, Johns Hopkins University School of Medicine

Virus. Wolfhard Weidel. Translated from the German by Lotte Streisinger. University of Michigan Press, Ann Arbor, 1959. 159 pp. $4.50.

Virology, in the popular literature, is usually portrayed as a science which deals with agents of disease and their control. It is refreshing to find a little book, such as this one, which depicts this science as one which investigates and can decipher some of the innermost secrets of life. This book is well written, fluent, and witty.

The reader will encounter, throughout the book, several gems of scientific wisdom. However, he may or may not agree with some of Weidel's own opinions. For example, I would find it difficult to defend the following statement: "The most important virus diseases have long been known, and the tedious search for new ones seems rather less appealing than collecting butterflies. Basic research is usually concerned with delving more deeply into experimental material already at hand" (page 35). It is also surprising that the author has faith that it will be possible to produce viruses in a test tube, just as starch granules are synthesized today (pages 103–104), but, at the same time, has little confidence in the eventual discovery of effective chemotherapeutic agents to control virus diseases (pages 148 and 150).

The major portion of the book is devoted to a description of the cycle of infection and multiplication of the virulent phage and culminates in a discussion of the mechanism of transfer of genetic information from parent to daughter DNA helices. References to other problems, including lysogeny, are brief. Although this is to be expected because of the scope of the book, one finds a contrast between the careful and detailed development of the bacteriophage topics and the simplified version of other phenomena.

The translation of the German text is not literal. It is unfortunate that the subtitle "Die Geschichte vom geborgten Leben" (the story of borrowed life) has been omitted, because it tends to define the scope of the book. The general organization and most of the specific information has been retained, but throughout the book several paragraphs of an introductory or concluding nature have been omitted or abbreviated. By a liberal translation much of the flowing style and humor of the German text has been maintained, but some alterations of meaning have been introduced. There are also some mistakes. For example, on page 46 "Reindarstellung" was rendered as "isolation" instead of as "purification"; in microbiology "isolation" has a quite different meaning. On pages 28 and 80 a common mistake is found: "Typhus" was translated as "typhus," although the author quite obviously meant "typhoid," which is caused by an entirely different microorganism.

The book contains good illustrations and an index. The format is very attractive, but the price may lessen its popularity among the general public.

In conclusion, the author should be commended for having made an excellent effort to elevate virology from an applied to a basic science, in the public mind.

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Studies in Mathematical Learning Theory. Robert R. Bush and William K. Estes, Eds. Stanford University Press, Stanford, Calif., 1959. viii + 432 pp. $11.50.

This collection of papers grew out of a summer institute on the applications of mathematics to social science research, which was held at Stanford University in the summer of 1957. It is fairly representative of current experimentation in the construction of mathematical theories of learning. The reader needs some knowledge and sophistication in psychology, and at least a speaking acquaintance with notions of matrices, difference equations, and probability. Even so, the psychologist may at times get lost in the mathematical manipulations, and the mathematician is equally likely to be puzzled by the psychological discussions; for there is an unfortunate tendency to use highly specialized psychological jargon without definition, to introduce new mathematical symbols without explanation, and to skip over long calculations as if they were obvious. The result of these stylistic faults is that to all but a small group of initiates (and one wonders whether this group is very much larger than the group of authors themselves) many of these papers will be somewhat mystifying. Nevertheless, for any one interested in applying mathematics to psychology or in finding out what mathematical psychologists are doing, this book is worthy of careful study.

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New Instruments and Methods of Engineering Geology. N. V. Glazov and A. N. Glazov. Translated from the Russian by J. Paul Fitzsimmons. Consultants Bureau, New York, 1959. 91 pp. $3.25.

This interesting little book describes new techniques used in engineering geology, hydrogeology, soil mechanics, soil science, and drilling operations. It relates mostly to new procedures currently used in Russia, but it also describes several techniques recently developed elsewhere, which presumably are novel to the Russians. The main emphasis of the volume is on the use of radioactive procedures. These pro-

cedures include (i) the use of beta and gamma radiation of earth and rock material both in the field and in specimens in the laboratory, primarily to determine density and water content of soils; (ii) the radiation of sand grains to serve as guides to sand movement; (iii) the addition of artificial radioactive glass grains to sands for use in tracing movement of the sand; and (iv) the coating of sand grains with phosphors that can be detected by ultraviolet light. One interesting procedure is the addition of salts of sodium 24 and 22 to water to trace its movement both on the surface and in the ground. Radioactive procedures are also used to determine changes in soil and water content of drilling muds in the course of drilling operations. Rapid means of measuring water content of soils by both mechanical and chemical methods are described. A vibrodrilling technique for rapidly procuring cores of soil to a depth of 20 to 30 feet is discussed at some length. The book closes with a description of safety measures to be used with radioactive procedures and with a series of tables describing the properties and cost in Russia of various radioactive isotopes. The volume contains relatively little material on rock mechanics or on geophysical tools, such as resistivity or seismic velocities. It has a bibliography of 43 titles, mostly Russian. The authors are highly objective in their approach to problems, listing both merits and disadvantages of the procedures described. Fitzsimmons' translation is idiomatic and is technically adequate. In my opinion the book contains much novel material, presented in an authentic manner.

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Glossary of Meteorology. Ralph E. Huschke, Ed. American Meteorological Society, Boston, Mass., 1959. viii + 638 pp. $10.

The glossary's purpose, stated in its preface, is "to define every important meteorological term likely to be found in the literature today."

It is an alphabetically arranged volume listing 7247 entries. Abbreviations and contractions which have been adopted as terms in themselves are included, but most common abbreviations are not.

The following are typical entries:

"ab-polar current—(Obsolete.) An air current moving away from either of the earth's poles."

"konimeter—(Also spelled conimeter) An instrument for determining the dust content of a sample of air. One form of the instrument consists of a tapered metal tube through which a sample of air is drawn and allowed to impinge upon a glass slide covered with a viscous substance. The particles caught are counted and measured with the aid of a microscope.

"*See* **dust counter**."

"Z-R relationship—*See* **radar reflectivity**."

New Books

Annual Review of Nuclear Science. vol. 9. Emilio Segrè and Leonard I. Schiff. Annual Reviews, Palo Alto, Calif., 1959. 633 pp. $7.

British Parasitic Fungi. W. C. Moore. Cambridge Univ. Press, New York, 1959. 446 pp. $8.50. This book provides a guide to the parasitic fungi reported on cultivated plants in Great Britain, the diseases they cause, and the British literature on the subject. The first part of the book is an alphabetical list of the scientific and common names of cultivated host plants, with the fungus parasites recorded on each host listed alphabetically under the scientific name of the host. The second part lists the parasites alphabetically and gives references to the place where each was first described.

Chemical and Molecular Basis of Nerve Activity. David Nachmansohn. Academic Press, New York, 1959. 246 pp. $7.50.

Encyclopedic Dictionary of Electronics and Nuclear Engineering. Robert I. Sarbacher. Prentice-Hall, Englewood Cliffs, N.J., 1959. 427 pp. The approximately 14,000 entries, alphabetically arranged, cover modern terms and definitions, equipments, elements, components, and systems in electronics and nuclear engineering. In the foreword to the volume, A. V. Astin says "*This* dictionary is especially valuable, for the fields of electronics and nuclear engineering have undergone so rapid an expansion in the past decade that a new jargon has sprung into being. Several of the professional societies have achieved considerable progress in standardizing many of the specialized terms in their areas. Dr. Sarbacher has made optimum use of these."

An Introduction to the Mechanics of Solids. Stephen H. Crandall and Norman C. Dahl, Eds. McGraw-Hill, New York, 1959. 454 pp. $8.50.

The Kinetics of Cellular Proliferation. Frederick Stohlman, Jr., Ed. Grune and Stratton, New York, 1959. 470 pp. $5.75.

Das Leben des Szelider Sees. Limnologische studien an einem natriumkarbonatchloridhaltigen see des ungarischen Alfold. Erno Donaszy. Akademiai Kiado, Budapest, Hungary, 1959. 425 pp.

Levels of Knowing and Existence. Studies in general semantics. Harry L. Weinberg. Harper, New York, 1959. 288 pp. $3.25.

The Lloyd William Taylor Manual of Advanced Undergraduate Experiments in Physics. Thomas Benjamin Brown, Ed. Addison-Wesley, Reading, Mass., 1959. 575 pp. $9.50.

Lymphocytes and Mast Cells. Margaret A. Kelsall and Edward D. Crabb. Williams and Wilkins, Baltimore, Md., 1959. 415 pp. $8.

Mechanisms of Hypersensitivity. Joseph H. Shaffer, Gerald A. LoGrippo, Merrill W. Chase, Eds. Little, Brown, Boston, Mass., 1959. 774 pp. $18.50. Papers from the symposium sponsored by the Henry Ford Hospital, 27–29 March 1958.

Metabolic Aspects of Renal Function. William D. Lotspeich. Thomas, Springfield, Ill., 1959. 228 pp. $7.50.

Minerals of New Mexico. Stuart A. Northrop. Univ. of New Mexico Press, Albuquerque, rev. ed., 1959. 681 pp. $10.

Open-Channel Hydraulics. Ven Te Chow. McGraw-Hill, New York, 1959. 698 pp. $17.

Physics of the Earth's Interior. Beno Gutenberg. Academic Press, New York, 1959. 252 pp. $8.50.

Physics and Geology. J. A. Jacobs, R. D. Russell, J. Tuzo Wilson. McGraw-Hill, New York, 1959. 436 pp. $9.75.

The Physiological Basis of Diuretic Therapy. Robert F. Pitts. Thomas, Springfield, Ill., 1959. 346 pp. $9.75.

Productive Thinking. Max Wertheimer. Enlarged edition edited by Michael Wertheimer. Harper, New York, 1959. 318 pp. $5.50.

Progress in Hematology. vol. 2. Leandro M. Tocantins, Ed. Grune and Stratton, New York, 1959. 296 pp. $9.75.

Report of the First Institute on Clinical Teaching. Helen Hofer Gee and Julius B. Richmond. Assoc. of American Medical Colleges, Evanston, Ill., 1959. 266 pp. Cloth, $3; paper, $2.

The School as Agent for Cultural Renewal. Fifth lecture in the "Burton Lecture" series. Lawrence K. Frank. Harvard Univ. Press, Cambridge, Mass., 1959. 55 pp.

Sons of the Shaking Earth. Eric R. Wolf. Univ. of Chicago Press, Chicago, Ill., 1959. 311 pp. $5.

Testing Statistical Hypotheses. E. L. Lehmann. Wiley, New York; Chapman and Hall, London, 1959. 382 pp. $11.

Turbulence. An introduction to its mechanism and theory. J. O. Hinze. McGraw-Hill, New York, 1959. 595 pp. $15.

Understanding Chemistry. Lawrence P. Lessing. Interscience, New York, 1959. 192 pp. $3.50.

The Wealth of India. Raw materials. vol. *5, H-K.* Council of Scientific and Industrial Research, New Delhi, 1959. 369 pp. R. 30.

Writing in Industry. vol. 1. Siegfried Mandel, Ed. Plenum Press, New York; Chapman and Hall, London, 1959. 121 pp. $2.75. Selected papers from the proceedings of the conference on writing and publishing in industry, sponsored by Polytechnic Institute of Brooklyn, 1959.

Reports

Geomagnetic Rotational Retardation of Satellite 1959α1 (Vanguard II)

Abstract. Radio observations made during the battery life of Vanguard II showed that the satellite's rotation was being retarded exponentially at a rapid rate. Precise analysis of electromagnetic couples on the conducting and magnetic parts of the satellite indicates a mean ambient geomagnetic field of 0.158 gauss, and confirms the eddy-current theory previously applied to Vanguard I.

During the four weeks of battery life after its launching on 17 Feb. 1959, the time-rate of radio intensity maxima for Vanguard II (1959α1) was observed with Minitrack by the tracking systems division of Goddard Space Flight Center, National Aeronautics and Space Administration. Since the nearly circular uniformity of the intensity pattern of the four antennas in the regular spin equator plane is said to make spin about that axis undetectable, the present observations are assumed to represent only precession of the regular equator, which is equivalent to rotation about an axis within 20° or so of that equator. Three-day means of these spin rates, plotted in Fig. 1 on a logarithmic scale against the date, follow a straight line having a relaxation interval (for rate to be divided by $e = 2.718$) of 72 days. Since the initial rotation rate ω_0 was 0.25 turn per second on Julian Date 2,436,616 (T_0), the smoothed empirical rates are represented by

$$\omega = 0.25 \exp [(616 - T)/72] \quad (1)$$

rotation per second for T = (J.D. −2,436,000) days. Substituting $t = 86{,}400T$, we obtain the equivalent formula

$$\omega = 0.25 \exp [1.62 \times 10^{-7}(t_0 - t)] \quad (1')$$

rotation per second for $(t_0 - t)$ in seconds; this form is better adapted to theoretical study. Since the moment of inertia of the satellite about an axis parallel to the regular spin equator was measured as $I = 1.977 \times 10^6$ gm-cm², comparison of Eq. 1′ with the general equation for damped rotation,

$$\omega = \omega_0 \exp [C(t_0 - t)/I\omega] \quad (2)$$

indicates that $C/\omega = 0.3205$ gm-cm²/sec is the braking couple constant which would have produced the observed retardation. As in the report on the analogous problem of Vanguard I (*1*), it seems reasonable to assume that practically all of this couple is due to magnetic damping. The following discussion is intended to confirm the previous finding that the mean geomagnetic field deduced from magnetic damping theory agrees with that to be expected from surface measurements.

Since the orbit of Vanguard II is essentially similar to that of Vanguard I, it will be sufficient, in order to find the expected mean total field $\overline{H}$ surrounding Vanguard II, merely to substitute the slightly different values of the mean geocentric distance $a = 1.30$ earth radii and eccentricity $e = 0.166$ into the revised (*2*) Eq. 15 of that report to find:

$$\overline{H} = \frac{0.335}{2.197\pi} \int_0^{\pi} \frac{dM}{(1 - 0.166 \cos M)^3} = 0.166 \text{ gauss} \quad (3)$$

(more exactly 0.160, by including higher order terms)

Likewise, the launching position and direction were approximately the same for Vanguard II as for Vanguard I, so the space orientation of the predominant spin-axis can be assumed to be the same. Thus, the expected effective mean field $\overline{H}_\perp$ (component perpendicular to the rotation axis) is found by applying the same reducing factor 1.15 given by the revised (*2*) Eq. 17 in the previous article (*1*), so that, using $\overline{H} = 0.160$,

$$\overline{H}_\perp = \overline{H}/1.15 = 0.139 \text{ gauss} \quad (4)$$

by Bauer's theory (*3*) based on surface measurements. The value of $\overline{H}_\perp$ found by equating the observed total damping couple constant $C/\omega = 0.3205$ gm-cm²/sec to the sum of electromagnetic couples pertaining to the various conducting parts of the Vanguard II satellite should agree with Eq. 4.

The outer cover of Vanguard II is a spherical shell of radius $r = 25.4$ cm and mean thickness $\Delta r = 0.073$ cm, including a very thin inner plating of copper, silver, and gold. It is essentially constructed of a magnesium alloy containing Al (3 percent), Mn (0.2 percent), and Zn (1 percent), for which the electrical resistivity $1/\sigma$ at 40°C is given as 10,000 electromagnetic units (emu) (*4*) and the magnetic permeability μ is unity. With these data, its resulting couple constant is:

$$C_0/\omega = (2\sigma\pi r^4 \Delta r \mu^2 H^2)/3 = 6.364\, H^2 \text{ gm-cm}^2/\text{sec-gauss}^2 \quad (5)$$

Inside the outer cover is a cylindrical can of the same metal, which contains most of the scientific apparatus. The cylindrical shell has a radius $r = 7.06$ cm, height $h = 33.66$ cm, and mean thickness $\Delta r = 0.10$ cm. Since the geometrical axis of the cylinder is normal to the plane of the antennas, the geomagnetic couple constant will be given by the equation for rotation about an axis perpendicular to it, namely:

$$\frac{C_1}{\omega} = \sigma\pi\, \mu^2 H^2 r^3 \left[\frac{h}{4} + \frac{11r}{24}\right] \Delta r = 0.129 H^2 \text{ gm-cm}^2/\text{sec-gauss}^2 \quad (6)$$

Other inside structural tubing of the same material is equivalent to eight cylinders, each having $h = 25.4$ cm, $r = 0.64$ cm, and $\Delta r = 0.089$ cm. By the same formula these have a total couple constant of $C_2/\omega = 0.001H^2$ gm-cm²/sec-gauss². This completes the discussion of all satellite parts large enough to experience a perceptible couple, *unless the smaller parts contain iron*. The cylindrical supports of the two "optics" have approximately $h = 5$ cm, $r = 5$ cm, and $\Delta r = 0.01$ cm, and are said to be of stainless steel, but since that material (*5*) is only very slightly magnetic ($\mu < 2$), the resulting couple constant would probably be no larger than C_2/ω, so it is neglected here.

The theoretical magnetic couple on any part involves the dimensions of this part and is always proportional to its spin rate ω and electrical conductivity σ, as well as to the square of the magnetic

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

induction B within the part. Since, for a surrounding field H, $B = \mu H$, where μ is the magnetic permeability of the material of the part, the couple will vary as the square of such permeability. From this arises the important fact that a part made of ferromagnetic material (for which type alone μ differs significantly from unity) may suffer a damping couple millions of times greater than that acting on one of the same size made of nonferrous metal. Thus, in the discussion of Vanguard I, it was found that the magnetic couple exerted on the steel cans of seven small mercury batteries was about half that on the remaining dominant mass of the satellite.

In the case of Vanguard II, the discussion of couples on ferrous material parts is further complicated by the existence in this satellite (*6*) of several permanent magnets: (i) the tape-recorder "record-playback" magnet, (ii) the "erase" magnet, (iii) the "record" motor field magnet, and (iv) the "playback" motor field magnet. Each of these magnets was surrounded in all except one direction by magnetic shielding of "mumetal" or other high-permeability material. Such shielding material would experience an extremely high couple relative to a rotating magnetic field. However, the net secular geomagnetic couple due to these permanent magnets and their shields is believed to be relatively small, and has been neglected here. The reason is that, with a vector **B** having a scalar value thousands of times that inducible by the earth's field, which already nearly saturates these bodies in a direction fixed in them, there would be negligible resultant vector changes $d\mathbf{B}/dt$ by which alone is induced a current producing the opposing (retarding) magnetic field. For instance, in a permanent magnetic field of 1000 gauss the earth's effective field of 0.1 gauss would produce a maximum nutation of the effective field of less than 10^{-4} radian, so that the mean effective couple would be only 10^{-4} that which would be produced if no permanent field were present.

As in Vanguard I there were many cold-rolled nickel-steel battery cans, for which was measured (*2*) a resistivity $1/\sigma = 12{,}500$ emu, and an effective initial (that is, weak field) magnetic permeability μ varying with dimensions and aspects. All cans in Vanguard II were assumed to be cylinders perpendicular to the rotation axis under consideration, so that their couple constants were evaluated according to Eq. 6. Thus, for the three types of Mallory battery: (i) 39 cells of type RM-12-R with mean $\mu = 40$, $r = 0.790$ cm, $h = 4.961$ cm, and $\Delta r = 0.0254$ cm had a total couple constant $C_3/\omega = 0.316H^2$ gm-cm^2/sec-gauss^2; (ii) 23 cells of type RM-502-R with mean $\mu = 48$, $r = 0.674$ cm, $h = 4.935$ cm, and $\Delta r = 0.0254$ cm had a total couple constant $C_4/\omega = 0.160H^2$ gm-cm^2/sec-gauss^2. (iii) 67 cells of type RM-640-R with mean $\mu = 35$, $r = 0.794$ cm, $h = 1.092$ cm, and $\Delta r = 0.0254$ cm had a total couple constant $C_5/\omega = 0.167H^2$ gm-cm^2/sec-gauss^2.

The predominant geomagnetic couple on Vanguard II was due to the iron cores of several transformers, for which the material is, of course, chosen for its high permeability. The two largest of these cores, in type SSO-3 transformers, were of "Double E" form—that is, approximately a double hollow-square laminant having outer width $h = 1.2$ cm, metal width $\Delta r = 0.4$ cm, and laminant thickness $d = 0.7$ cm. The total couple constant for both cores having their rotation-axis perpendicular to d is approximately:

$$\frac{C_6}{\omega} = \sigma\,\mu^2 H^2 d\left[\frac{h^3\Delta r}{2} - \frac{3h^2(\Delta r)^2}{2} + 2h(\Delta r)^3 - (\Delta r)^4\right] = 9.480\,H^2 \text{ gm-cm}^2/\text{sec-gauss}^2 \quad (7)$$

The material of these cores was an iron containing 49 percent nickel, for which was assumed (*7*, *8*) a resistivity $1/\sigma = 50{,}000$ emu at 45°C, and permeability $\mu = 2300$ for a very weak field. Four other smaller transformers of DOT type have cores of the same alloy in the form of a torus with mean radius $R = 0.24$ cm and thickness $\Delta r = 0.16$ cm, for which the total couple constant would be given approximately by:

$$\frac{C_7}{\omega} = \sigma\mu^2 H^2 \pi^2 R^3\,(\Delta r)^2 = 0.369H^2 \text{ gm-cm}^2/\text{sec-gauss}^2 \quad (8)$$

The smallest ferromagnetic couples in Vanguard II to be considered here are the cylindrical cores of five relay switches, for which $h = 2.54$ cm, $r = \Delta r = 0.15$ cm, and the axis of rotation is assumed to be perpendicular to the geometrical, so that Eq. 6 may be applied to give $C_8/\omega = 0.023H^2$. For this result the material has been assumed (*9*) to be ordinary "relay steel," a 4-percent silicon iron having resistivity $1/\sigma = 60{,}000$ emu and initial permeability $\mu = 500$.

Collecting all the above theoretical couple constants, and equating the sum to that derived from the observed rotational damping, gives the equation:

$$\sum_{n=0}^{8}\frac{C_n}{\omega} = (6.364 + 0.129 + 0.001 + 0.316 + 0.160 + 0.167 + 9.480 + 0.369 + 0.023)H^2 = 0.3205 \text{ gm-cm}^2/\text{sec} \quad (9)$$

or $17.009H^2 = 0.3205$, so that $H^2 = 0.01884$, and an effective mean field normal to the spin-axis of $\bar{H}_\perp = 0.137$ gauss would theoretically explain the observed retardation. Since the actual values for metallic properties such as magnetic permeability may vary somewhat, the close agreement with Eq. 4 is somewhat fortuitous, but even the same order of magnitude would seem to confirm the geomagnetic theory of observed rotational retardation.

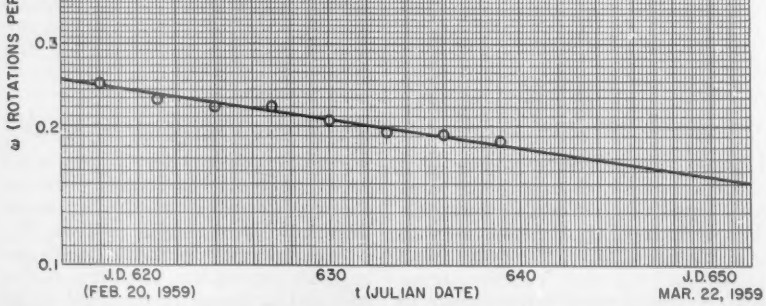

Fig. 1. Observed spin rate versus time for Vanguard II (1959α1). The straight line represents exponential decay with a relaxation time of 72 days.

Although the accuracy of this theoretical value of $\bar{H}_{\perp}$ has been increased by direct measurements of electrical and magnetic properties of some pertinent parts, which must be as near as possible like those in Vanguard II, there is little hope for such exact magnetometry as in the case of Vanguard I. For this scientific purpose Vanguard I has the relative advantages of magnetic simplicity, as well as continuing rotation observations, both radio and optical. The practically uniform specular surface of Vanguard II would seem to preclude any rotational observations after the battery life limit shown in Fig. 1.

For future practical considerations, it is interesting to note that, if the magnetic shields used in Vanguard II (of "mumetal," a favorite material for such purposes, since $\mu > 20{,}000$) had not been well saturated by interior permanent magnets, the damping couple would have been thousands of times greater than that deduced here, and the relaxation time shorter by the same factor. In this case the entire magnetic evolution of the artificial rotational motion—damping, precession, and nutation—would have been completed in about a day, and thereafter any such motion would merely follow the local vagaries of the earth's magnetic and gravitational fields.

This remarkable sensitivity of highly permeable magnetic material to its ambient field suggests its possible exploitation for orientation control of space vehicles. The present investigation indicates, by Eqs. 2 and 5, that, if the outer shell had been of mumetal, the satellite would have become directionally "locked" in the earth's field within a second of time. Could not properly designed and oriented rings of mumetal be used as rudders to supplement more complicated gyroscopic devices for direction control of space observatories?

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References

1. R. H. Wilson, Jr., *Science* **130**, 791, (1959).
2. ———, *Science*, in press [revision of (*1*)].
3. L. Bauer, *Terrestrial Magnetism* **28**, 24, (1923).
4. G. Pogonis, *Light Metals Handbook* (Van Nostrand, Princeton, N.J., 1954), p. 42.
5. S. Hoyt, *Metal Data* (Reinhold, New York, 1952), p. 299.
6. R. Hanel, R. A. Stampfl, and others, *Electronics* **38**, 44 (1959).
7. T. Spooner, *Properties and Testing of Magnetic Materials* (McGraw-Hill, New York, 1927), pp. 48–51.
8. *International Critical Tables* (McGraw-Hill, New York, 1927), vol. VI, p. 397, fig. 27.
9. H. Roters, *Electronic Devices* (Wiley, New York, 1941), p. 494.

2 October 1959

Potential Genetic Variability of Wild Pairs of Drosophila melanogaster

Abstract. Eleven of 21 wild pairs of *Drosophila melanogaster* tested gave rise to at least 1 fly with crossvein defects out of 1000 F_2 progeny. Considered in the light of additional information, the results support the idea that an individual possesses to a large degree the potential variability of the population of which he is a member.

Any ordinary sexual population, if allowed to reproduce maximally, would soon give rise to a vast array of variant individuals (*1*). Even the descendants of only one pair, under similar conditions, would give rise to a great number of variant individuals. Just how the potential genetic variability of a pair compares with that of a whole population is a question that the experiment reported here was designed to approach.

Rather than attempt the impossible task of cataloging the variation produced in each case, I have taken a single example of phenotypic variation and investigated the proportion of individual wild pairs capable of giving rise to such a variant in the F_2 generation.

In wild populations of *D. melanogaster*, on the order of 1 in 1000 individuals has defective posterior crossveins. This trait has been found in *Drosophila* all over the world, and it is controlled (with rare exceptions) by a number of polygenes, probably about five, found on all three major chromosomes and studied by several workers (*2*). The rare but ubiquitous crossveinless phenodeviants (*3*) are flies in which rather common genes occur in rare combination—a situation rather analogous to that in which a spade is drawn out of a full deck of cards seven times out of ten.

If indeed the genes are so common, it follows that a large fraction of all wild pairs have the potential for producing offspring that include at least a tiny proportion of crossveinless flies. The experiment under discussion was set up to determine whether this is actually the case.

Twenty-one wild inseminated females were collected in their natural habitat, five grocery stores in Ann Arbor, Mich. Such females can be treated as wild pairs. All proved to be fertile. The 21 groups of F_1 flies were then inbred to produce 1000 F_2 flies each for analysis. The number of crossveinless flies in the F_2 generation was noted, each fly being rated as to the degree of crossvein defect, from 0 (normal) to 12 (posterior crossvein completely absent). This procedure involved two departures from natural conditions. First, as stated, the F_1 flies were inbred. Second, the flies were raised at a temperature of 18° ± 1°C. The inbreeding caused an increase in the total number of crossveinless (*cve*) flies observed but probably did not markedly alter the number of pairs giving rise to at least one crossveinless fly. Also, the *cve* genes are better expressed at 18° than at 25°C, but again this does not seriously alter the significance of the results.

Table 1 lists the strains of flies and the number of crossveinless individuals produced. It will be seen that 11 of the 21 strains contain at least one crossveinless fly in the F_2 generation. We may conclude, then, that at least half the wild pairs contain at least one of each gene necessary to produce the rare combination leading to the *cve* phenotype. These results confirm a preliminary experiment carried out in 1958 in which four out of seven wild pairs produced at least one crossveinless fly out of 1000 flies in the F_2 generation.

It is not certain that all crossveinless flies carry the same *cve* genes; indeed, this is improbable in the light of a comparison of certain results obtained by myself and others on various strains selected to breed true for the crossveinless trait (*4*). In addition, no set of *cve* genes has been so completely characterized as to permit a unique formulation of the distribution of these genes in a population.

It can easily be shown, however, that the estimate of "at least half the

Table 1. Crossveinless flies in F_2 progeny of wild pairs; 1000 flies were counted in each case. Letters represent the grocery stores from which the original females were collected. Total percentage of crossveinless flies, 0.6.

Strain	Crossveinless flies (*N*)
AP-1	1
AP-2	2
AP-3	7
AP-4	0
AP-5	1
MD-1	0
MD-2	0
MD-3	36
R-1	0
R-2	9
R-3	1
R-4	0
R-5	5
R-6	0
S-1	0
S-2	0
S-3	0
S-4	45
S-5	0
W-1	7
W-2	5

wild pairs" represents a minimum, for it appears likely that pairs with only one of each necessary gene between them would produce far fewer than 1 crossveinless fly in 1000 F_2 flies.

Support for two suggestions is lent by this experiment: (i) that of Dobzhansky and his co-workers that an individual often possesses an unexpectedly great portion of the total genetic variation of its population (*5*); (ii), that the presently observable steps in evolution are made through new combinations of common genes (*5*), which have therefore already been long since tried and tested by natural selection as members of an individual's team of genes (*6*).

Finally, it is suggested that results such as these should be borne in mind in the consideration of the many polygenic traits in human beings.

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References and Notes

1. T. Dobzhansky, *Genetics And The Origin of Species* (Columbia, New York, 1951), pp. 65 ff.
2. C. H. Waddington, *The Strategy of The Genes* (Macmillan, New York, 1957); K. G. Bateman, thesis, University of Edinburgh (1956); J. D. Mohler, *Proc. Intern. Congr. Genet., 10th Congr. Montreal* (1958); R. D. Milkman, thesis, Harvard University (1956); —, *Proc. Intern. Congr. Genet., 10th Congr. Montreal* (1958).
3. I. M. Lerner, *Genetic Homeostasis* (Oliver and Boyd, Edinburgh, 1954).
4. K. G. Bateman, personal communication (1955); J. D. Mohler, personal communication (1955).
5. T. Dobzhansky, H. Levene, B. Spassky, N. Spassky, *Genetics* 44, 75 (1959).
6. This work was done with the aid of two grants from the Horace H. Rackham School of Graduate Studies of the University of Michigan: Faculty Research-Research Equipment project No. 129 and Horace H. Rackham research project No. 420.

21 August 1959

Relationship of Stress-Induced Histidine Decarboxylase to Circulatory Homeostasis and Shock

Abstract. Histidine decarboxylase activity of mouse tissues is increased by stress and by injection of epinephrine and norepinephrine, suggesting a balance between histamine and catechol amines producing a component of circulatory homeostasis. Imbalance during intense stress might lead to failure of circulatory homeostasis and to shock. Reasons for discounting histamine as "shock toxin" may be invalid.

Workers in this laboratory have recently demonstrated that mammalian histidine decarboxylase is an adaptive enzyme (*1*); its activity in animal tissues increases in response to nonspecific stress, for example, treatment with histamine liberators, burns, delayed allergy, treatment with pertussis vaccine (*2*), exposure to cold, and injection with *Escherichia coli* endotoxin (*3*).

Among the most firmly established consequences of stress are discharge of epinephrine from the adrenal and release of norepinephrine from the sympathetic nerve endings. The catechol amines seemed likely chemical mediators of stress-induced histidine decarboxylase activity and were consequently tested.

Mice were injected intramuscularly with 20 μg of epinephrine in oil; controls received oil only. The animals were killed after 6 hours, and tissues were assayed for histidine decarboxylase activity (*4*). Results for skin of control mice were 87, 96, and 117 (av., 100); for skin of epinephrine-treated mice, 339, 348, and 466 (av., 384). Results for lungs of control mice were 42, 94, and 163 (av., 100); for lungs of epinephrine-treated mice, 367, 408, and 510 (av., 428). Thus the histidine decarboxylase activity of mouse skin and lung was increased fourfold (*5*). This has been repeatedly confirmed. Histidine decarboxylase activity of muscle was increased threefold under these conditions; other tissues are under investigation.

Results of a time study of the effects of 20 μg epinephrine in oil were as follows: for skin of control mice, 96, 97, and 107 (av., 100); for mice killed 1 hour after injection, 74, 75, and 84 (av., 78); for mice killed 6 hours after injection, 447, 454, and 575 (av., 492); and for mice killed 24 hours after injection, 97, 104, and 139 (av., 113).

Norepinephrine also increased histidine decarboxylase activity. Mice were injected subcutaneously with aqueous solutions of DL-norepinephrine equivalent to either 20 μg or 60 μg of the *l*-isomer. Each received three injections 2 hours apart. After 6½ hours the skins were assayed. For controls the values were 89, 104, and 107 (av., 100); for mice receiving three 20-μg doses of norepinephrine, 253, 312, and 375 (av., 313); for mice receiving three 60-μg doses of norepinephrine, 436, 493, and 593 (av., 507).

The earlier demonstration (*2*) that activity of histidine decarboxylase increases in response to diversified forms of stress becomes more comprehensible in view of the fact that catechol amines, known to be released in stress, also increase enzyme activity. These observations suggest that there may be a balance between the two catechol amines on the one hand, and newly synthesized histamine on the other, producing a component of circulatory homeostasis which operates under conditions of stress.

It is further suggested that in those conditions of stress where there is ultimately a failure in circulatory homeostasis, for example, traumatic shock, one of these amines may be a causative factor.

The intense adrenergic stimulation preceding stress-induced shock is well recognized; now we have demonstrated that stress increases the activity of the enzyme which synthesizes histamine. Although it has not been proved that increased in vitro histidine decarboxylase activity in the mouse is a measure of the rate of histamine synthesis in the tissues of the living animal, (*6*, *7*) this has been done in the rat (*1*). The importance of the shock problem and the attractiveness of a concept involving new formation of histamine seem to justify speculation based on the assumption that stress increases histamine synthesis in vivo. The hypothesis is therefore proposed that if during stress the supply of either histamine or the catechol amines fails, the remaining amine may be extraordinarily toxic to the cells of the small blood vessels and cause shock. The lethal effect of either amine when acting on such cells in the absence of its natural antagonist may be much greater than heretofore suspected, since in experimental tests on these drugs there is probably always some compensation by release or formation of the antagonist.

There are two obvious possibilities for explaining certain features of some types of shock in terms of an imbalance in the catechol amine-histamine relationship. First, histamine may not be formed in adequate supply in strategic locations, so that it cannot cope with catechol amines from the adrenals and sympathetic nerve endings. In this case, excessive vasoconstriction may produce hypoxia with resulting damage to the cells of the small blood vessels.

Second, intense stress may result ultimately in some degree of depletion of the catechol amines from their depots. Thus a highly active mechanism for synthesizing histamine might be left in operation. Injected histamine can produce shock in animals of many species; if formed throughout major tissues of an animal whose defenses are to some extent exhausted, it may cause severe damage.

Adrenal steroids released during stress also oppose some actions of histamine in some species; however, the degree of depletion and rate of resynthesis of these steroids during stress is not clear and their role cannot be evaluated at this time.

In certain types of shock there is good reason to believe that histamine may be the shock "toxin." Adrenalectomized animals are highly sensitive to shock and to histamine; yet they

can be injected with large amounts of epinephrine and norepinephrine. Cortisone, which antagonizes some effects of histamine, is reported to protect adrenalectomized rats from traumatic shock (*8*). In many cases of shock, adrenergic stimulation is probably extremely strong in the early stages before histidine decarboxylase has reached full activity; yet often the death of the animal is delayed. During long-continued infusions of epinephrine in man and some other species a strong drop in blood pressure occurs; if the infusion is abruptly terminated, shock may ensue (*9*). Finally, bacterial endotoxins produce shock closely resembling stress shock (*10*); *Escherichia coli* endoxin is an extremely strong inducer of histidine decarboxylase activity in many tissues (*3*).

Other possibilities relating the histamine-catechol amine balance to shock are that different tissues of the same animal may be injured by different amines, or, that once a cell is injured, all the amines may be toxic to it.

In the early research on shock, numerous workers considered histamine, or histamine-like substances, as likely candidates to be shock "toxin" (*11*). It has been dropped almost entirely from consideration at the present time. Some of the reasons are the following: (i) there are differences in the characteristics of stress-induced shock and shock produced by injection of histamine; (ii) the histamine content of normal muscle is too low to cause shock when the muscle is traumatized; (iii) histamine is not consistently found in blood and lymph in increased quantities during shock; (iv) antihistamines do not protect against shock.

Recent findings suggest that histamine may be newly synthesized at an increasing rate during stress, that it may act for long periods of time, that it may be formed close to, or possibly even within the cells which it stimulates, and that it is rapidly inactivated, forming metabolites for which there are no suitable analytical procedures (*7*). If these conjectures are correct, the reasons for discounting histamine as a shock "toxin" can no longer be considered valid (*12*).

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References and Notes

1. R. W. Schayer, Z. Rothschild, P. Bi.ony, *Am. J. Physiol.* **196**, 295 (1959).
2. R. W. Schayer and O. H. Ganley, *ibid.* **197**, 721 (1959).
3. R. W. Schayer, unpublished results.
4. Histidine decarboxylase was assayed by incubation of tissue extracts with 10 μg of C^{14} L-histidine for 3 hours at 37°C and determining the C^{14} histamine formed by addition of carrier, isolation, conversion to dibenzenesulfonylhistamine, and counting in a liquid scintillation counter. The method has been described in detail (*1*). All values for enzyme activity were recalculated so that the average of the controls is arbitrarily 100. This permits easier comparison of results of experiments done at different times and under different conditions.
5. There are at least two distinct types of histidine decarboxylase according to function; one is in mast cells and certain other unidentified cells and produces histamine which is largely bound. The second is the inducible histidine decarboxylase; its anatomical location is not known. The histidine decarboxylase in tissues of normal animals may be largely, perhaps entirely, due to the first type; hence the increase in the inducible histidine decarboxylase activity may be much greater than indicated by the data.
6. Histamine catabolism is complex in mice (*11*) and there is no satisfactory method for measuring histidine decarboxylase activity in vivo in this species. Therefore, only in vitro studies were made. In female rats histamine catabolism is simpler, and in these animals we have previously shown that results of in vitro experiments on induced histidine decarboxylase are parallel to those obtained from experiments in living animals (*1*).
7. R. W. Schayer, *Physiol. Revs.* **39**, 116 (1959).
8. B. N. Halpern, B. Benacerraf, M. Briot, *Brit. J. Pharmacol.* **7**, 287 (1952).
9. W. D. M. Paton in *Progress in Allergy* (Karger, New York, 1958), vol. 5, p. 123.
10. J. Fine, in *Shock and Circulatory Homeostasis* (Josiah Macy, Jr. Foundation, New York, 1955).
11. C. J. Wiggers, *Physiology of Shock* (Commonwealth Fund, New York, 1950).
12. I gratefully acknowledge the expert technical assistance of Mrs. Piroska Houlihan, Mrs. Elena Sestokas, and Mr. Lee Chapin.

3 September 1959

Critical Periods for the Effects of Infantile Experience on Adult Learning

Abstract. Mice were shocked with 0.1, 0.3, or 0.5 ma of current at 2 to 3, 8 to 9, or 15 to 16 days. Handled, nonshocked and nonhandled controls were also used. In adulthood each group was split into thirds and taught an avoidance response under shock of 0.3, 0.5, or 0.7 ma. The amount of shock given during infancy and adulthood, and the age at which shock occurred, were all found to have significant effects upon learning.

Several investigators have recently studied the question of critical periods in infancy (*1*). On the behavioral level, Schaefer (*2*) has reported that rats handled during the first week of life exhibit less emotionality in adulthood than animals handled at other times. Denenberg has shown that rats handled during the first 10 days of life are better avoidance learners in adulthood than rats handled during the second 10 days or the first 20 days of life (*3*), and that mice shocked at different times during early life have differential adult conditioning scores as well as different response topologies (*4*). On the physiological level, Levine and Lewis (*5*) have determined that rats manipulated (handled) at ages 2 to 5 days and 2 to 13 days exhibit significant adrenal ascorbic-acid depletion when assayed at 14 days, but that animals handled at 6 to 9 or 10 to 13 days do not show any evidence of depletion. Denenberg and Karas (*6*) used rats and mice which were either not handled at all or were handled for the first 10, the second 10, or the first 20 days of life; the groups handled for 20 days weighed the most, but animals handled for the first 10 days lived longest under conditions of total food and water deprivation.

It has also been shown that shock administered to mice at 25 days will significantly affect 50-day conditioning scores (*7*), and that shock administered on two days between the 5th and 10th days of life will lead to more rapid extinction of a learned response (*4*). However, there has been no systematic study of the relatively long-term behavioral effects of stimulation given to restricted age groups at different critical periods in infancy. We wish to describe some of the findings of such a study (*8*).

The subjects were 290 mice (strain C57BL/10Sc). They were stimulated at one of three ages: 2 to 3 days, 8 to 9 days, or 15 to 16 days. These ages are at the mid-point of the first three critical periods specified by Williams and Scott (*9*) and specified with modifications by one of us (*4*). Stimulation consisted of removing the complete litter from the home cage, placing the pups on a grid, and subjecting them to one of three levels of constant current: 0.1, 0.3, or 0.5 ma. Ten 1-second shocks were administered, with a 45-second pause between shocks. Handled, nonshocked controls (0.0 ma) were treated in the same way as shocked mice, except for lack of current on the grid. In addition, other litters served as nonhandled, nonshocked controls. All litters were weaned at 22 days and reared thereafter in small cages with littermates of like sex. At 61 days of age the 13 groups were randomly split into thirds and received avoidance learning conditioning under shock of 0.3, 0.5, or 0.7 ma. They received six trials a day for 7 days. The conditioning consisted of the sounding of a buzzer, followed 5 seconds later by shock. If the mouse made the appropriate response prior to the onset of shock, the shock did not occur and the mouse was credited with an "avoidance response."

Figure 1 presents the mean number of avoidance responses as a function of the level of shock given during adulthood for each of the three critical periods. Separate graphs are given for each level of shock given during infancy. The curve for the nonhandled, nonshocked control groups is based on the same mice in each of the graphs. With this one exception, each point of

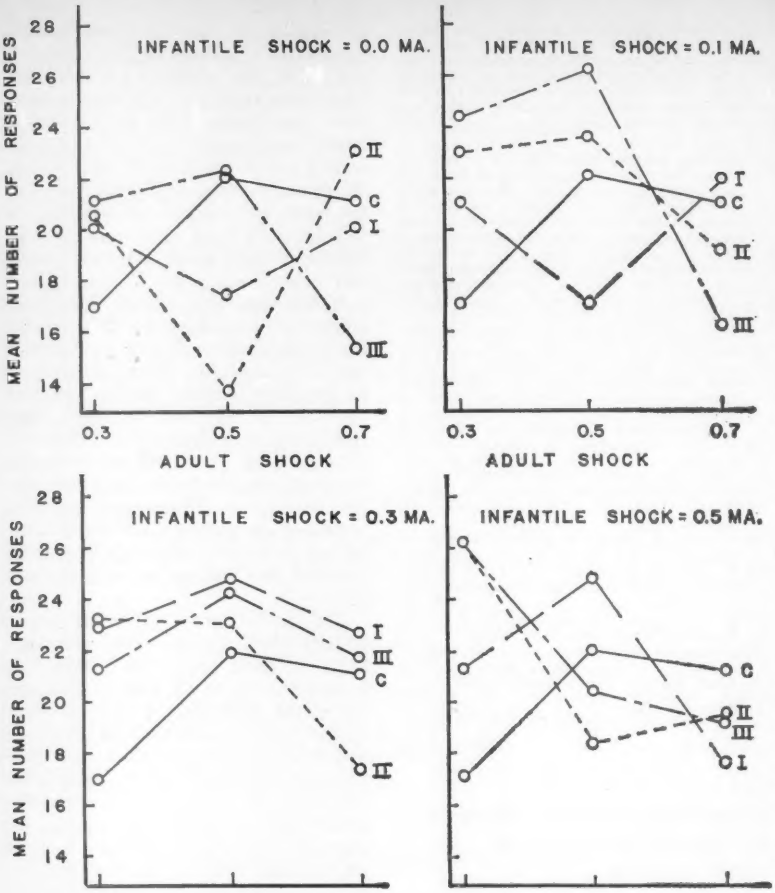

Fig. 1. Mean avoidance score as a function of intensity of shock given during adulthood for each critical period. Each level of shock given during infancy is graphed separately. (I) Critical period No. 1, 2 to 3 days; (II) critical period No. 2, 8 to 9 days; (III) critical period No. 3, 15 to 16 days; (C) nonhandled, nonshocked controls.

the curves is based upon independent groups of mice from at least two different litters, with n ranging from 7 to 11 per group. The analysis of variance of these data consisted of the main effects of critical periods (C), infantile shock (I), adult shock (A), and all interactions. The analysis showed significant differences beyond the 0.01 level for the main effects of infantile and adult shock, and for the C-A and C-I-A interactions; the I-A interaction was significant at the 0.05 level. Though C was not significant as a main effect, it was present in two of the significant interactions, and the importance of this variable was thereby established.

The above analysis did not include the three nonhandled, nonshocked control groups. Each of these control groups was compared with the 12 groups stimulated in infancy which received the same level of shock in adulthood. At 0.3 ma of shock in adulthood, all stimulated groups had significantly higher learning scores than the control group; at 0.5 ma, four of the stimulated groups scored significantly higher than the control, while four other groups scored significantly lower; at 0.7 ma, four of the stimulated groups had means which were significantly lower than that of the control group. Thus, stimulation during infancy facilitated learning at the low-adult-drive level but depressed learning at the high-drive level. This finding differs from data recently obtained with the rat, in which it was found that the effects of handling during infancy upon avoidance learning was independent of the level of shock that was employed during adulthood (*10*).

The data definitely show that the age at which stimulation occurs and the magnitude of stimulation during infancy and adulthood, singly or in combination, are major parameters which affect learning scores. Whether the stimulated mice will learn more or less rapidly than the controls is a function of particular combinations of these three variables. The data confirm the previous findings on the effects of stimulation during infancy upon learning in the mouse (*4*, *7*). They are also consistent with observations of Levine and Lewis (*5*), who found that handling at ages 2 to 5 days modified the ascorbic-acid response in the rat; however, Levine and Lewis failed to find a significant effect from handling at 6 to 9 days, while we were able to obtain significant results from stimulation given at 8 to 9 days.

We should like to emphasize the extreme sensitivity of young mice to external environmental stimulation, especially at ages 2 to 3 days. It is apparent that, somehow, different levels of shock in infancy differentially affect the mouse, since the learning scores differed, even when the same level of shock was employed during adulthood. We should also like to point out that such a subtle environmental factor as transporting a mouse from its nest to the shock apparatus and back (0.0 ma) is sufficient to modify its learning scores when it is an adult. The mechanisms that bring about these behavioral changes are not known. The mouse is at markedly different stages of growth and development between 2 and 16 days of age; for example, the neuroanatomical, physiological, and perceptual motor capabilities change qualitatively during this period. Because of these major differences in maturation, it is our feeling that the same physical stimulation at these different ages has qualitatively different effects upon the developing organism.

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References and Notes

1. J. P. Scott, *Psychosom. Med.* **20**, 42 (1957).
2. T. Schaefer, thesis, University of Chicago (1957).
3. V. H. Denenberg, paper presented at the 1958 meeting of the American Psychological Association.
4. ———, *J. Psychol.* **46**, 211 (1958).
5. S. Levine and G. W. Lewis, *Science* **129**, 42 (1959).
6. V. H. Denenberg and G. G. Karas, *ibid.* **130**, 629 (1959).
7. V. H. Denenberg, *Psychol. Rept.* **5**, 357 (1959).
8. This investigation was supported in part by a grant from the Purdue Research Foundation and by grant M-1753 from the National Institute of Mental Health of the National Institutes of Health.
9. E. Williams and J. P. Scott, *Behaviour* **6**, 35 (1953).
10. V. H. Denenberg and G. G. Karas, in preparation.
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14 September 1959

Relation of Antigens of Melampsora lini and Linum usitatissimum to Resistance and Susceptibility

Abstract. A specific antigen was found in each of four races of *Melampsora lini* and four rust-differentiating varieties of *Linum usitatissimum*. Avirulence and virulence were related to resistance and susceptibility through the specific rust antigens. A race was virulent to varieties containing its specific rust antigen as a minor constituent, and avirulent to varieties lacking that antigen. No such correlation was found with flax antigens.

Numerous investigations have failed to determine the nature of the physiological or hypersensitive type of resistance to infection by rust fungi. Resistance in the host and pathogenicity in the parasite have been inherited as simple Mendelian characters in most instances (*1*).

The use of serologic methods as an approach to the problem is suggested by the complementary gene interaction hypothesis. This concept proposes that the mechanism governing resistance may be conditioned by a host-parasite interaction somewhat similar to an antigen-antibody reaction (*2*). Serology has been used to rank wheat varieties for rust resistance (*3*) and in studies of pollen incompatibility substances (*4*). It is significant that immunogenetics points to a direct relation of genes and antigens whereby the detection of antigens provides an immunochemical approach to the study of genes (*5*).

This report presents results of an investigation of antigens in rust-differentiating lines and varieties of *Linum usitatissimum* L. and in races of *Melampsora lini* (Ehrenb.) Lev.

Lines of flax, which are essentially alike except that each possesses a different rust-conditioning gene, were developed by backcrossing on the rust-susceptible variety Bison. In addition to Bison, lines selected from the seventh backcross to Bison of Cass, Koto, and Ottawa 770B were studied.

Two pairs of races of *Melampsora lini* having the widest differences in pathogenicity were used. The pathogenicity genotype of the urediniospore culture of each race was established by selfing. Race 22 is virulent on 23 of 25 differentials that are monogenic for rust reaction. Avirulence on Ottawa 770B differentiates race 19 from race 22. Race 1 is virulent on 4 of the 25 differentials. Virulence on Koto differentiates race 210 from race 1.

Resistance and avirulence are dominant in the lines of the host and in the races of the parasite used in this study. The reactions of each line of flax to the four races are shown in Table 1.

Globulins were prepared from the urediniospores of each race of rust and from each line of flax for use as antigens. The urediniospores were produced in the greenhouse on susceptible hosts, germinated in tap water for 6 hours at 15°C, and ball-milled with 3 percent salt solution. The suspensions were centrifuged to remove cellular debris and the supernatants were treated with 60 percent acetone to precipitate the globulins, which were frozen and dried under vacuum.

The flax globulins were prepared from greenhouse-grown plants in the prebloom stage. The plants were homogenized in a Waring blender with 3 percent salt solution. Plant and cellular debris were removed by centrifugation, and the globulins were precipitated from solution with 60 percent acetone, then frozen and dried under vacuum.

The globulins of each variety and race were reconstituted in physiological saline and used as antigens in the preparation of specific rabbit antisera. Precipitin titers for each antiserum were determined by the antiserum dilution method of Martin (*6*). Analyses for the various antigens present in each globulin were then carried out with each specific antiserum by precipitation reactions involving both cross-titrations and absorption tests.

The cross-titrations gave specific homologous titers of 1:2560 for each antiserum, and heterologous titers of 1:20 to 1:320, which showed that each globulin was characterized by a specific major antigen. The absorption tests demonstrated that each globulin differentially contained some of the other antigens as heterologous minor constituents which constituted a characteristic mosaic. Thus, each globulin contained not only its specific antigen, but also certain of the rust antigens as well as certain of the flax antigens.

Resistance and susceptibility were correlated to the titers of rust antiserum with flax antigens. As shown in Table 1, host-parasite interaction was susceptible when titers of rust antiserum against flax antigens were 1:160 or 1:320 and resistant when the titers were 1:20 or 1:40.

The relation of the specific rust antigens to resistance and susceptibility was more clearly shown by the absorption tests. In nine out of ten host-parasite combinations, flax varieties having a specific rust antigen as a minor constituent were susceptible to races characterized by that antigen. In all six host-parasite combinations flax varieties lacking a rust antigen as a minor constituent were resistant to races characterized by that antigen.

The absorption data suggest that in the cross-precipitation tests the association of titer differences to resistance and susceptibility is due to the presence or absence of the rust antigens in the varieties or lines of the host. The presence of a rust antigen in a flax variety would account for heterologous rust antiserum titers of 1:160 and 1:320 and the absence of the rust antigen would account for titers of 1:20 and 1:40.

Table 1. Association of rust reaction (R, resistant; S, susceptible) with rust antiserum titers against flax antigens. The flax varieties are shown in italic type.

M. lini, race 1	*M. lini*, race 19	*M. lini*, race 22	*M. lini*, race 210
	Cass × *Bison 7*		
R 1:40	S 1:320	S 1:160	R 1:20
	Koto × *Bison 7*		
R 1:40	S 1:320	S 1:320	S 1:320
	Ottawa 770B × *Bison 7*		
R 1:40	R 1:40	S 1:320*	R 1:20
	Bison		
S 1:320	S 1:320	S 1:160	S 1:320

* No antigen detected in absorption tests.

Positive correlations were observed only with the rust antigens and rust antisera. No correlations were observed for the characteristic flax antigens or flax antisera, either for reaction or pathogenicity.

The specific globulin antigen of each race of rust was associated with the virulence of that race. On the other hand, the presence or absence of the rust antigens in the flax varieties was associated with the resistance or susceptibility of the variety (*7*).

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References and Notes

1. T. Johnson and M. Newton, *Can. J. Research, C* **18**, 599 (1940); H. H. Flor, *J. Agr. Research* **74**, 241 (1947).
2. D. Catcheside, *The Genetics of Micro-organisms* (Pitman, London, 1951); H. H. Flor, *Advances in Genet.* **8**, 29 (1956).
3. C. I. Nelson and J. M. Birkland, *J. Agr. Research* **38**, 169 (1929); A. E. Edgecomb, *Botan. Gaz.* **91**, 1 (1931).
4. D. Lewis, *Proc. Roy. Soc. (London)* **140**, 127 (1953).
5. K. Landsteiner, *Specificity of Serological Reactions* (Harvard Univ. Press, Cambridge, Mass., 1945); L. C. Ferguson and C. Schultz, *Science* **129**, 937 (1959).
6. D. S. Martin, *J. Lab. Clin. Med.* **28**, 1477 (1943).
7. This article is a contribution of the departments of bacteriology and agricultural chemistry, North Dakota Agricultural Experiment Station, and the Crops Research Division, U.S. Agricultural Research Service, and published with the approval of the director of the North Dakota Agricultural Experiment Station.
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24 August 1959

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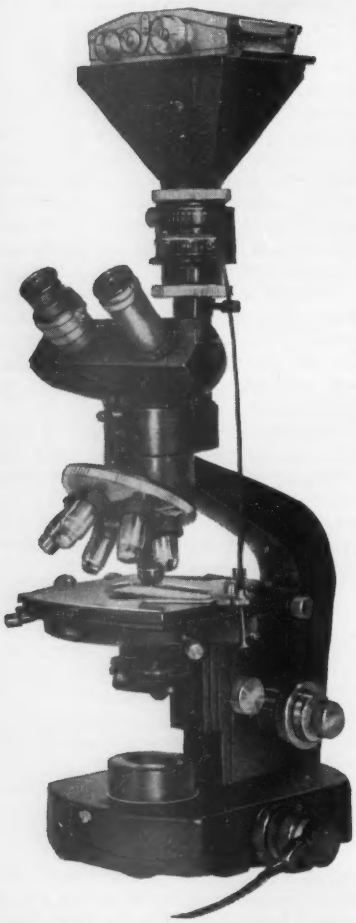

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Letters

Assessment of Fallout Hazards

J. Gordin Kaplan's very readable letter [*Science* **130**, 728 (1959)] raises some interesting points concerning possible effects of fallout Sr^{90}. Kaplan mentions our studies on high-radium water and bone tumors in the Midwest. There is a preliminary report on this by one of us [L. D. Marinelli, *Am. J. Roentgenol.* **80**, 729 (1958)]. It is now established that some hundreds of thousands of persons have subsisted on water exceeding the maximum permissible Ra^{226} level for large populations, and several thousand, on water with a Ra^{226} content above five times that level.

No areas of significantly increased prevalence of bone tumors related to this exposure have as yet been observed, or can be detected in vital statistics as reported over the past 15 years. Final results of our bone-tumor survey cannot, however, be reported for some time, since it requires careful checking of all cases to rule out such major artifacts as diagnostic errors and areas of occupational and medical overexposure which may affect determination of the true incidence of this rare disease.

We would like to call attention to what is apparently a serious error of fact. Kaplan has suggested "studying" data from Russian reports cited by Engström *et al.* [*Bone and Radiostrontium* (Wiley, New York, 1957), p. 133] which indicate that dogs injected with 0.0001 μc of Sr^{90} per gram developed osteosarcoma 3 years later. We have indeed made a study of this remarkable citation, and it appears that it embodies an error: the dosage given is too low by a factor of about 1000. Our own experience would indicate that this degree of tumor response is characteristic of dosages of about 0.1 μc of Sr^{90} per gram. This is corroborated by published Russian reports [*Summaries of Papers presented at the Conference on Remote Consequences of Injuries Caused by the Action of Ionizing Radiation* (State Medical Literature Press, Moscow, 1956)] and by more recent Russian reviews of the subject [N. A. Kraevsky, *Blastomogenic Effects of* Sr^{90} (Ministry of Health of the U.S.S.R., Moscow, 1958)]. In our own laboratory, injection of 0.01 μc of Sr^{90} per gram in three dogs has induced no tumors, nor in fact has it induced any visible changes in bone structure after 12 years.

The most likely source of this error is the paper of E. V. Erieskova (in the *Summaries* cited above), which describes bone sarcoma in dogs receiving radiothorium (Th^{229}) in dosages of 0.0001 μc/g. This agrees with data obtained by the University of Utah Atomic Energy Project. Radiothorium may be expected, on a basis of microcuries injected per gram, to be between 60 and 600 times as toxic as Sr^{90}. The former figure takes into account only total energy release within the bone; the latter includes consideration of the relative biological effectiveness of alpha particles and the fact that deposition is concentrated in areas of active cellular growth. Another possible source of error might lie in the fact that a translator not versed in the subject could confuse millicurie (мкюри) with microcurie (мккюри). In any case the citation seems to be apocryphal and erroneous.

While a number of other points might be made, one other seems particularly worthy of being brought to Kaplan's attention. The data cited, which indicate that concentrations in "hot spots" in bone and concentrations in other or average areas differ by a factor of 40, are derived from observations where there has been a single injection of isotope. This factor naturally disappears (or nearly disappears) where exposure occurs throughout a major proportion of the individual's life-time, including infancy, since Sr^{90} is laid down along with normally deposited calcium, in more or less proportional amounts. In this case, hot spots are not observed.

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Argonne National Laboratory, Lemont, Illinois

J. Gordin Kaplan deplores the assessment of fallout danger issued by the General Advisory Committee of the Atomic Energy Commission. He urges the committee to consult a biologist, but his letter contains evidence of such serious deficiencies in his understanding of radioactivity that it does not encourage one to place confidence in the advice of the biologist. For example, he argues that radiation reaching the body from outside is largely irrelevant to the subject of potential dangers from fallout, and he uses the childish analogy of comparing throwing rubber balls at a person to a person's swallowing a ball.

He seems unaware of the fact that cosmic rays penetrate the body and leave a trail of ions all along the path they traverse, and that they penetrate many times more tissue than the weak beta particles from Sr^{90}. Consequently the cosmic-ray background is exceedingly pertinent to an assessment of the dangers from radioactivity, and the fact that the inhabitants of Denver do not show a higher incidence of leukemia and other cancers than the inhabitants of New York, although the Denverites are exposed to 60 percent more cosmic

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radiation, is strong evidence supporting the argument that a linear proportionality does not exist between biologic injury and radioactivity in the range of natural intensities.

Kaplan also seems to be ignorant of the importance of K^{40}, which is naturally radioactive, emits a more energetic beta particle than Sr^{90}, and is present in the body in such quantities that the average adult body experiences about 200,000 K^{40} disintegrations per minute. It is responsible for about one-third of the total background radiation taken into consideration by the General Advisory Committee.

Kaplan further makes the mistake of equating 1000 r at microscopic hot spots with 1000 r of total-body radiation. This kind of large error in quantitative reasoning is not uncommon among biologists. Many students of aquatic ecology, for example, count the numbers of organisms per liter of water without estimating their body mass. Thus, they attach the same importance to a *Chlorella* cell, with a volume of 50 μ^3, that they attach to a *Ceratium* cell, with a volume of 100,000 μ^3.

Finally, Kaplan selects a single experiment, which purports to demonstrate that 1 μc of Sr^{90} caused bone cancers in dogs, and places so much confidence in it that he says this concentration is "known to cause cancer in dogs." He ignores the principle that experiments should be reproducible—that until several laboratories have verified these results we cannot say that 1 μc of Sr^{90} is "known to cause cancer in dogs."

Until we biologists display more wisdom in our interpretation of the hazards of radioactivity than is displayed in Kaplan's letter, we can hardly urge the General Advisory Committee to seek our advice.

JACOB VERDUIN
Biology Department, Bowling Green State University, Bowling Green, Ohio

The first of the three points made by Brues, Auerbach, and Marinelli in their interesting comment concerns their studies on the relation between Ra^{226} in the water supply and in bone of human beings on the one hand and induction of bone cancer on the other. The statement of the General Advisory Committee of the Atomic Energy Commission about which I recommended caution was that "the amount of strontium-90 which has been found in food and water is less of a hazard than the amount of radium normally present in public drinking water supply in certain places in the United States."

Now, there is evidence that Sr^{90} in the food of human beings quickly approaches equilibrium with that in human bone (*1*). The increase in Sr^{90} concentration in human bone seems roughly to parallel that in the diet: from midyear 1955 to midyear 1957, the mean concentration of Sr^{90} in the diet (North America and Western Europe) has risen 1.8 times, and that in human bone has risen about 1.6 times during the same period (*2*). Kulp *et al.* have shown that it is possible to predict with considerable accuracy the skeletal levels of Sr^{90} from dietary concentrations (*2*, Fig 2). With respect to radium, the sparse data presently available do not seem to permit one to conclude that the situation is the same. Data cited by Marinelli (*3*, Fig. 1) show that the range of variation for the Ra^{226} skeletal burden in man is roughly 20 times less than the corresponding variation in the Ra^{226} concentration in drinking water. Indeed, within the range of 0.01 to 0.1 $\mu\mu$c of Ra^{226} per liter of drinking water there seemed to be no corresponding significant variation whatever in skeletal burden for this isotope. Further, Marinelli cites data showing that the mean skeletal burdens of Ra^{226} in the Illinois communities of Joliet, Aurora, and Elmhurst are about 15 times the mean skeletal burden in Chicago, but that the water supplies of the first three communities have about 150 times the concentration of Ra^{226} that the water supply of Chicago has.

Hence, I repeat that "we had better treat . . . with suspicion" all statements citing high radium and thorium levels in the human diet as reassuring evidence of the harmlessness of radiostrontium.

My letter concluded with an argument concerning the possible hazards from the Sr^{90} levels in human bone likely to result from nuclear-test explosions already completed. This argument included reference to Russian experiments on induction of osteosarcomata in dogs by low levels of Sr^{90}, which had been cited by Engström *et al.* (*4*). I am very grateful to Brues, Auerbach, and Marinelli for pointing out that the citation was erroneous; let me add, by the way, that I am considerably relieved, as well. I stated that I was putting forward the argument "in order to solicit a refutation"; this Brues and his colleagues have provided, and I should like therefore to withdraw the argument.

With respect to their final point, one should point out that the absence of "hot spots" in what Björnerstedt and Engström (*5*) call chronic conditions of Sr^{90} poisoning does not necessarily imply that this substance has a completely homogenous distribution in bone. Under these conditions, the Swed-

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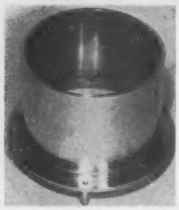

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ish authors point out that "the Sr^{90} concentration may be expected to vary from the average by a factor of about 2 for the 15 year period and by successively larger factors for longer periods." As for the present situation, they state that "today the Sr^{90} contamination of the geosphere and the biosphere is steadily increasing. This corresponds to a situation with aspects that lie somewhere between those of acute and chronic Sr^{90} poisoning conditions. Children in the 0- to 5-year age group are examples of individuals with chronic poisoning conditions. Adults above 20 years of age are more likely to be examples of acute poisoning."

Detailed consideration of Verduin's letter is supererogatory, as it seems largely irrevelant to my own. However, his errors must not be allowed to pass unchallenged. In the recent summary analysis of hearings, the Joint Committee on Atomic Energy stated: "As in 1957, testimony at the 1959 hearings indicated that strontium-90 and cesium-137 are still considered to present the greatest hazard in worldwide fallout . . . But short-lived isotopes, such as Sr^{89}, I^{131}, Ba^{140}, Zr^{95}, and others, were described by several witnesses as worthy of more consideration or as being even potentially as hazardous as Sr^{90} and Cs^{137}" (*6*). My letter stated that "the principal dangers . . . to the human race from fallout stem from the decay of the radioactive fallout material after it has been taken into the body and incorporated within certain cells and tissues." This statement is correct; it is nonsense to bring up cosmic rays and naturally occurring K^{40} in this connection, as they obviously have nothing to do with the matter.

We might have been spared the little lecture on "aquatic ecology" had I stated that the 1000 rads was the approximate dose received by the lungs of the Joachimsthal miners (*7*), not by their whole bodies. I regret this careless error.

I think Verduin is quite wrong in saying that "the fact that the inhabitants of Denver do not show a higher incidence of leukemia . . . is strong evidence supporting the argument that a linear proportionality does not exist between biological injury and radioactivity in the range of natural intensities." This fatigued red herring, which Linus Pauling calls "the Denver argument" (*8*), ought finally to have been exorcized (if that is what one does to red herrings) by the report of Buck, "Population size required for investigating threshold dose in radiation-induced leukemia" (*9*). Buck states: "At an altitude of 6000 feet, the annual excess of cosmic radiation over that received at sea level is approximately 23 mr, or 1.5 r by age 65. I attempted to examine leukemia death rates by altitude in the United States, only to realize that it was

extremely unlikely that the effect of such a small dose, even if it existed, could be demonstrated as statistically significant with the sizes of populations available."

Finally, I must disagree with Verduin's quaint notion that any of my own supposed or, alas, real deficiencies of knowledge make it unwise or unnecessary for the General Advisory Committee to rely on the advice of biologists in preparing a statement about biology. An individual, such as Verduin or I or anyone else, should and must speak out freely at the command of his conscience, even at the risk of making a fool of himself. I stated, and I repeat, that it is presumptuous of an official committee, whose membership comprises not one biologist, to issue what purports to be a definitive statement on a crucial biological matter. This would be so even if the statement did not include the misleading material to which I have drawn attention.

Following my own advice, I conclude by repeating my urgent conviction that nuclear bomb tests must not be resumed.

J. GORDIN KAPLAN
Department of Physiology, Dalhousie University, Halifax, Nova Scotia

References

1. F. J. Bryant, A. C. Chamberlain, G. S. Spicer, M. S. W. Webb, *Brit. Med. J.* **1**, 1371 (1958).
2. J. L. Kulp, A. R. Schulert, E. J. Hodges, *Science* **129**, 1249 (1959).
3. L. D. Marinelli, *Am. J. Roentgenol.* **80**, 729 (1958).
4. A. Engström *et al.*, *Bone and Radiostrontium* (Wiley, New York, 1957).
5. R. Björnerstedt and A. Engström, *Science* **129**, 327 (1959).
6. *Science* **130**, 613 (1959).
7. P. Alexander, *Atomic Radiation and Life* (Penguin, Baltimore, 1957).
8. L. Pauling, *No More War!* (Gollancz, London, 1958).
9. C. Buck, *Science* **129**, 1357 (1959).

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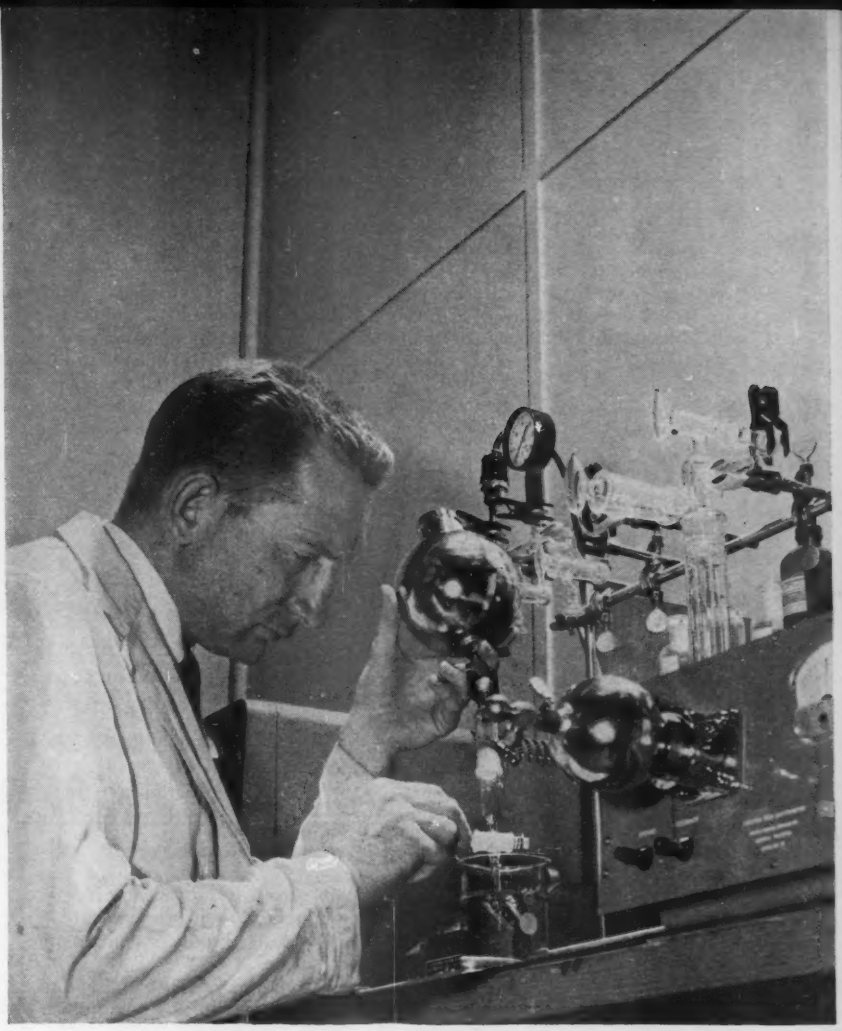

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stance, through abstracts); readable texts (preferably not reduced on microfilm); and easy access to the world's literature.

I do not claim to solve the problem in this letter but I want to draw attention to the undiscovered possibilities in the present set-up of abstracting services and automatic searching systems.

It is quite wasteful, both of intellectual manpower and money, to continue as we are now going. Far better service could be produced by more limited means. The greatest trouble seems to lie in the very strength and vested interests of the existing abstracting services. There is, however, no urgent need to put these aside; on the contrary, through close cooperation of these interests, duplication of efforts might be avoided.

It would be worth while to consider the establishment, in place of the many hundreds of abstracting services in all disciplines that now exist, of a limited number of such services—one or two for each branch of science. These should not duplicate each other. These services—with an excellent staff of abstractors, obtained through combining the existing services—would adequately cover the field. These major abstracting centers would be provided with the best machinery available for searching the literature. Moreover, these centers would cooperate with a few regional centers for translation of abstracts into particular languages.

The user would then place subscriptions for abstracts in the subjects in which he has a particular interest. The abstracting services would use an internationally accepted classification system, so that orders might be placed without language difficulty. Such an abstracting service, for instance, would be able to supply abstracts covering certain subjects in a certain country during a certain period; or it would meet broader requests, even requests for complete coverage of scientific literature.

In those cases where the demand for abstracts on a given subject is regular, information could be obtained more quickly through specialized national centers which would receive copies of the material abstracted at the international centers.

For efficient operation, the abstracting services should rely on national depository centers of primary publications. These centers need not necessarily be national libraries or the like, as these do not exist in all countries, but could be set up for each discipline in cooperation with the international abstracting services. Wherever possible, however, central national services should be created, if they do not yet exist, in order to eliminate the possibility of duplication of work and, what is worse, loss of primary material.

A selection of the more important materials for abstracting would be made by the national centers. The remainder might be recorded in bibliographical lists only.

I have not mentioned, so far, the production of original literature. It would be very difficult to eliminate publication in journals, conference reports, and so on. If, however, everything produced is deposited nationally, there would be no danger of loss (unclassified military reports and the like are not discussed here). The abstracting services would publish classified lists of everything produced, whereas the contribution itself need not be produced in print but could be deposited only in manuscript form. Any request for a full paper—which a user would select from the abstracts or lists—could be met by supplying a photocopy or film of the manuscript—or, if published, of the periodical article.

As a first step towards the realization of this program, a conference of the editors-in-chief of some 25 of the bigger abstracting services should be convened to study the possibility of reducing the number of services by pooling manpower and money. Then the program of national services for primary publication should be studied.

Mention should be made here of the work of the International Council of Scientific Unions Abstracting Board, under the direction of Professor Boutry.

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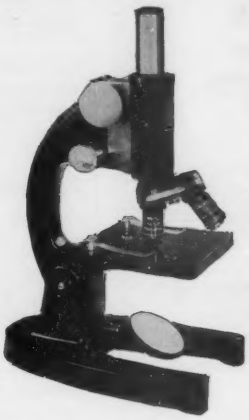

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Perceptual Constancy

The very interesting findings by Leibowitz and Hartman on developmental changes in the magnitude of the moon illusion [*Science* **130**, 569 (4 Sept. 1959)] remain ambiguous in one respect. The data of Fig. 1 indicate that the illusion—that is, the disparity between the perceived sizes of the horizontal and overhead disks—diminishes with increasing age. The authors attribute this lessening of the illusion to an increase in the phenomenal size of the overhead disk; in other words, the perceived size of the overhead disk more nearly approaches its objective size—that is, constancy. One could, however, just as easily attribute the shrinkage of the illusion to a *decrease* in the apparent size of the horizontal disk, which would mean that with increasing maturity perception becomes less constant, that one perceives the moon at the horizon more nearly in terms of retinal size. It is not safe to say that the authors' interpretation is the logical one in the light of known principles of perceptual development, for, as C. E. Osgood [*Methods and Theory in Experimental Psychology* (Oxford, New York, 1953), pp. 227-280] points out, the evidence on developmental changes in constancy is at best inconclusive and at worst downright confusing.

One possible way of removing the ambiguity is to test the authors' conclusions in a size-distance constancy experiment for objects in both the overhead and horizontal positions. Such an experiment might show (i) that constancy increases with age for objects at the zenith; (ii) that constancy decreases with age for objects at the horizon; or (iii), that both (i) and (ii) occur. I would be willing to bet on (iii). Or the authors might want to try out the related hypothesis that individuals who habitually operate in three-dimensional space —construction workers, circus aerialists, aviators—are less subject to the moon illusion than the rest of us horizontal-oriented mortals.

JOSEPH CHURCH
Department of Child Study, Vassar College, Poughkeepsie, New York

Church's argument is logical if one assumes that the present state of research on developmental changes in perceptual constancy is indeed inconclusive. In Osgood's discussion, the confusion results from considering size and brightness constancy together. Since it has been demonstrated that the different constancies are most probably mediated by different mechanisms [H. Leibowitz, P. Chinetti, and J. Sidowski, *Science* **123**, 688 (1956)], it seems advisable to evaluate size constancy separately. In this context, the studies cited by Osgood as well as the more recent experiments referred to in our original note indicate that size constancy does improve with age, especially for distant objects. On the basis of this evidence, we were led to suggest the hypothesis proposed in the original note rather than the alternative possibility that was suggested by Church.

Church has also suggested that individuals who habitually make discriminations with respect to objects outside of the horizontal plane may demonstrate a decreased moon-illusion effect. We have made no systematic observations on this point, but it is relevant to mention that two of the 19 adult subjects demonstrated no illusion effect whatsoever. Upon further questioning, it was revealed that one of them had worked as a forest ranger while the other is an amateur pilot. Further experimentation is certainly indicated, but the available data are in agreement with part of Church's hypothesis.

H. LEIBOWITZ
THOMAS HARTMAN
Department of Psychology, University of Wisconsin, Madison

Ethology and Psychology

The title of the Sixth International Ethological Conference, recently held at Cambridge University, again focuses attention on the problem of what to call the rapidly developing science of animal behavior. The term *ethology* has been defined by Tinbergen [in B. Schaffner, Ed., *Group Processes* (Macy Foundation, New York, 1955)] as "the biological study of behavior." Since psychology in its modern sense is often defined as "the science of human and animal behavior," it is obvious that these two terms overlap and may be almost identical.

This presents the possibility of a jurisdictional dispute as well as an unreal dichotomy of subject matter, and one wonders why a new term should be needed. The answer lies both in the history and in the professional organization of science. Psychology has concerned itself primarily with human be-

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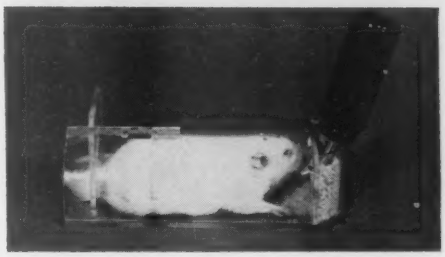

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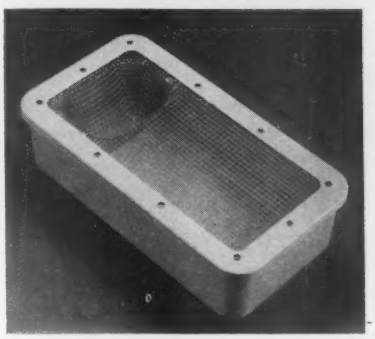

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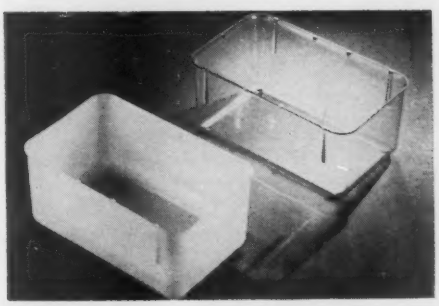

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havior and only secondarily with the behavior of the rest of the animal kingdom. On the other hand, a zoologist who concerns himself with animal behavior does not like to call himself a psychologist, nor does the term *animal behaviorist* fit with the usual nomenclature of subdivisions of biological science. There is no term equivalent to "behaviorology"; this is one case where the Greeks did not have a word for it.

Both *ethology* and *psychology* are unfortunate terms because of their derivation. *Ethology* originally meant the science of character, whereas *psychology* meant the science of the mind. Thus, both are based on primitive scientific concepts which no longer have much use and do not describe modern science. In addition, *ethology* is very similar to *ethnology*, a term long used in a purely human context to describe studies of race. According to J. R. Charles, it is linguistically permissible to pronounce *ethology* with a long *e*, and this should be done in order to make a greater phonetic distinction between it and *ethnology*.

There are two conventional ways of subdividing the study of biology. One of these is on the basis of taxonomic groups—that is, ornithology, entomology, bryology, and so on. The other, a more basic one, is based on phenomena observed on different levels of organization, with ecology at the topmost level and genetics at the lowest, and with developmental biology (or, as it used to be called, embryology) cutting across all levels. The phenomenon of behavior, defined as activity of an entire organism, occupies a central position on the organismic level. Its study involves factors operating at all levels of organization, and this provides a natural way of unifying zoological science. The scientist who studies behavior is likely to be by training a geneticist, a physiologist, an ecologist, or a sociologist as well as a psychologist, and he cannot work effectively without some appreciation of factors affecting behavior on other levels. This interdisciplinary nature of the study of behavior has been often recognized in terminology by combining the names of different fields of science—for example, *psychobiology*, *sociobiology*, *psychogenetics*, *physiological psychology*, *social psychology*, and so on. Most of these terms still describe a field of interest rather than a profession, although they may eventually develop into the latter.

No one can dictate what the eventual usage will become. However, certain principles should be kept in mind. One is that we should define whatever names we give to the science of animal behavior in the broadest possible way, recognizing that this science deals with general phenomena affected by many different sorts of factors and cutting across the conventional boundaries of professional training. Thus, *ethology* should be defined as the study of behavior of all animals, including man, thereby being a term equivalent to *psychology* rather than excluding it. It would be unfortunate for the development of the science if it were confined to the study of instinct and thereby became merely one of the already numerous minor schools of psychology.

It is also possible that workers in the field of animal behavior will find that their concepts have gone beyond the original narrow definition of their science, just as did the embryologists, who found that development did not cease with embryonic life but proceeded into old age and death. By analogy, the science of animal behavior might become known as "behavioral biology."

More important than terminology, however, is the existence of important behavioral phenomena and concepts explaining them which tend to eliminate the somewhat artificial divisions of zoological science which have hitherto been used in the organization of professional training.

J. P. SCOTT
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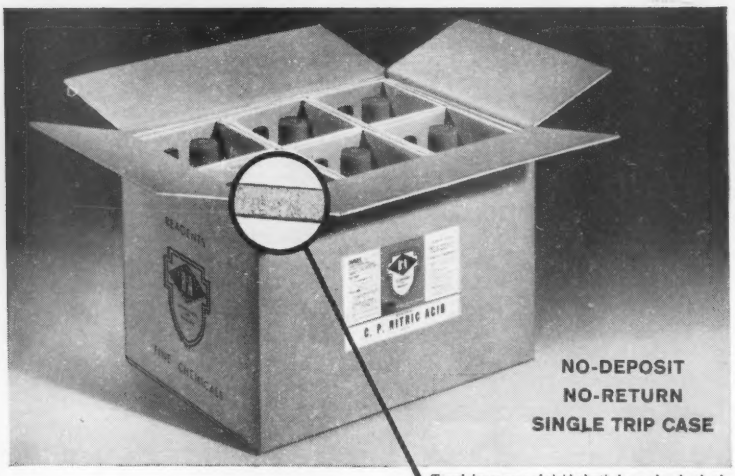

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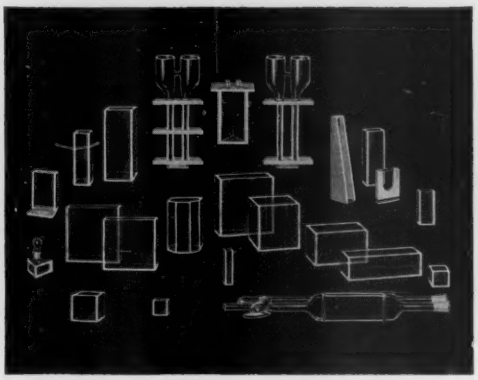

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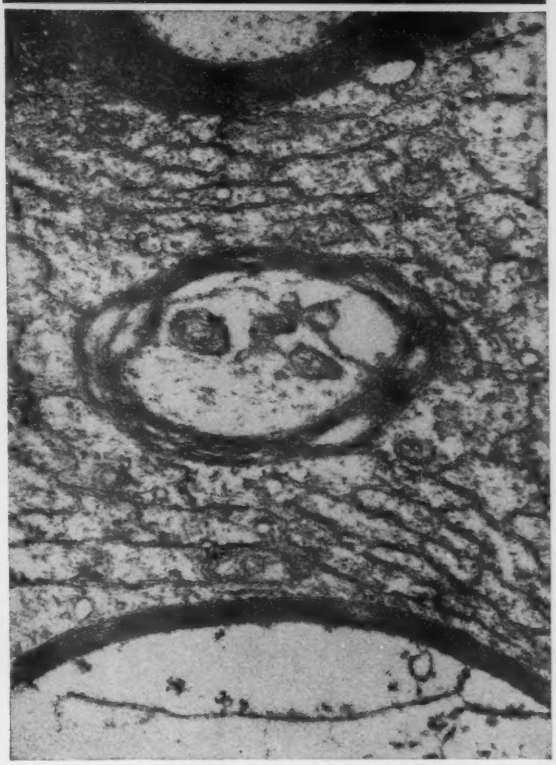

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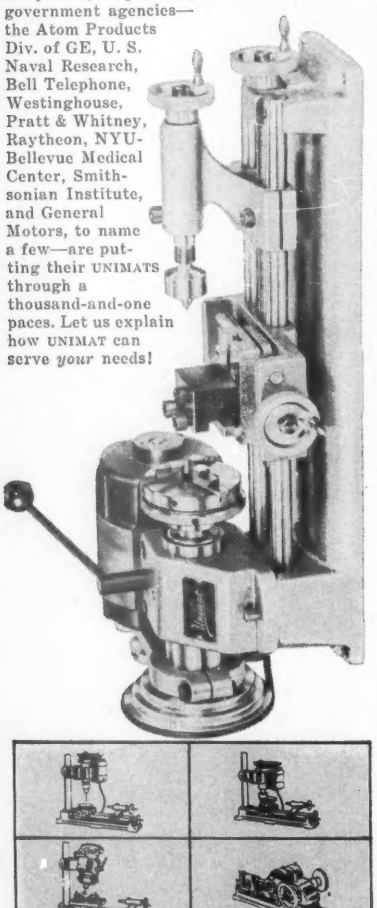

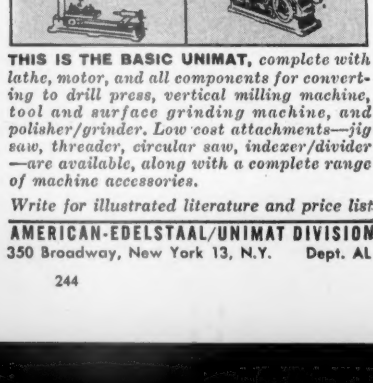

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Meetings

The British Association

The annual meeting of the British Association for the Advancement of Science, with a registration of about 3000 persons, was held this year in the city of York, where the association held its first meeting 128 years ago. At that earlier meeting most of the visiting scientists arrived by stagecoach or on horseback. In the succeeding years the association has held four other annual meetings in York. The objectives of this annual meeting of the British Association are to provide a platform for leading scientists to present current reviews of their areas of specialization, to provide for discussion by workers of problems which cut across scientific divisions, and to provide to nonspecialists and the lay public discussion of scientific advances in a comprehensible form.

Special features of the program included a young people's program, with lectures on atomic energy, giant computing machines, man and insects, and dinosaurs and Darwinism. Given programs, involving 40 separate technical films, constituted the scientific film program. These selected films included contributions from ten foreign countries as well as many from Great Britain. Three new general lectures, known as the Lister, Darwin, and Kelvin lectures, were presented. The Lister lecture was an applied-psychology discussion by D. E. Broadbent, "Time to React"; the Darwin lecture was a botanical discussion by R. G. West, "The Ice Age"; and the Kelvin lecture was a microbiology discussion by S. Brenner, "Building Viruses."

Each of the 14 sections held a series of technical sessions, and numerous excursions were planned for afternoons and for the week-end, which occurred in the middle of the meeting. This is held by custom from Wednesday to Wednesday—a tradition established in the early days so that those traveling by stagecoach would not have to travel on Sunday.

Special entertainment included a garden party given by the city of York, receptions and luncheons for foreign guests, a symphony concert by the Northern BBC orchestra, and a formal banquet in the Muchan Adventurers Hall. The president of the association, Sir James Gray, gave his presidential address, "The Proper Study of Mankind is Man," at the opening session on 2 September. This address and the addresses of the section presidents will appear in the current number of the association's publication, *Advancement of Science.*

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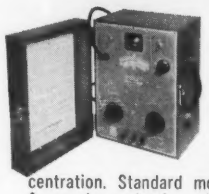

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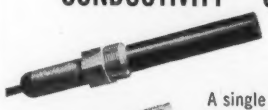

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adopted a number of changes in general organization structure, including membership, meeting, and publication activities, so the current year should provide some interesting developments. The new president for the coming year is to be Sir George Thomson of Cambridge University, who will give his formal presidential address at the Cardiff meeting in 1960. A number of foreign guests attended and these were recognized by the association and by the city of York. The American Association for the Advancement of Science was represented by Wallace R. Brode, retiring president and chairman of the board of directors.

WALLACE R. BRODE
Department of State, Washington, D.C.

Forthcoming Events

February

18–20. National Soc. of Professional Engineers, winter, Wichita, Kan. (P. H. Robbins, NSPE, 309 Bancroft Bldg., Univ. of Nebraska, Lincoln.)

21–24. American Inst. of Chemical Engineers, Atlanta, Ga. (F. J. Van Antwerpen, AICE, 25 W. 45 St., New York 36.)

22–25. Technical Assoc. of the Pulp and Paper Industry, annual, New York, N.Y. (J. Winchester, TAPPI, 155 E. 44 St., New York 17.)

22–4. Scientific Management, 12th intern. cong., Sydney and Melbourne, Australia. (C. M. Gray, Federal Council of the Australian Inst. of Management, Western House, 83 William St., Melbourne, C.1, Victoria, Australia.)

24–26. Biophysical Soc., 4th annual, Philadelphia, Pa. (O. H. Schmitt, Biophysical Soc., Chairman, Program Committee, Univ. of Minnesota, Minneapolis.)

25–27. American Orthopsychiatric Assoc., Chicago, Ill. (Miss M. F. Langer, 1790 Broadway, New York 19.)

25–27. Cell Physiology of Neoplasia (14th annual symp. on fundamental cancer research), Houston, Tex. (Editorial Office, Univ. of Texas M. D. Anderson Hospital, Texas Medical Center, Houston 25.)

26. Highway Geology, 11th annual symp., Tallahassee, Fla. (W. F. Tanner, Geology Dept., Florida State Univ., Tallahassee.)

28–5. American College of Allergists, Miami Beach, Fla. (E. Bauers, 2160 Rand Tower, Minneapolis 2, Minn.)

29–3. American College of Surgeons, Boston, Mass. (H. P. Saunders, 40 E. Erie St., Chicago, Ill.)

29–4. Pittsburgh Conf. on Analytical Chemistry and Applied Spectroscopy, Pittsburgh, Pa. (L. P. Melnich, U.S. Steel Corp., Monroeville, Pa.)

March

3–5. American Acad. of Forensic Sciences, Chicago, Ill. (W. J. R. Camp, AAFS, 1853 W. Polk St., Chicago 12.)

4–6. National Wildlife Federation, Dallas, Tex. (C. H. Callison, 232 Carroll St., NW, Washington 12.)

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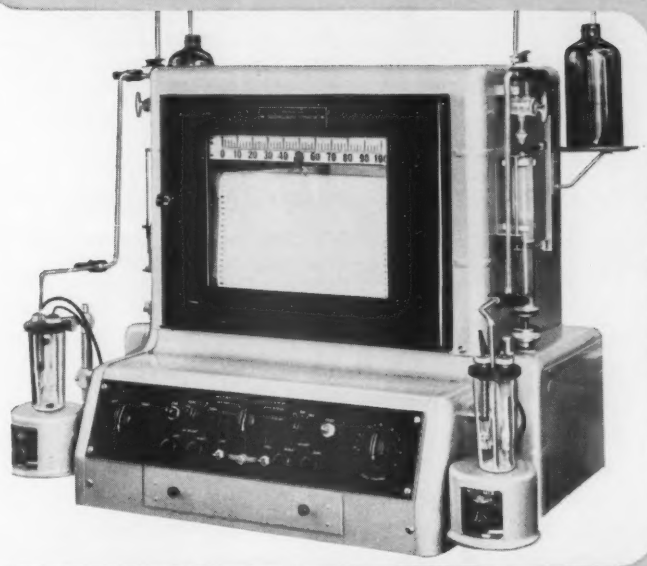

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AAAS Symposium Volume No. 55

Editor: Robert B. Withrow

Proceedings of the Gatlinburg Conference on Photoperiodism, 29 October–2 November 1957, sponsored by the Committee on Photobiology of the National Academy of Sciences–National Research Council and supported by the National Science Foundation. Preface by Alice P. Withrow.

57 papers by 75 authors. 6 x 9 inches, 921 pages, 256 illus., genera and species index, subject index, cloth, 1959. Price $14.75. AAAS members' cash orders $12.50.

The volume surveys the plant and animal facets of photoperiodism and portrays a diversity of approaches in the study of photoperiodic phenomena in a wide range of organisms. The various papers are presented from the perspectives of the photochemist, biochemist, plant physiologist, and zoologist and are by well-recognized members of the various disciplines. This is a unique and stimulating contribution toward the understanding of photoperiodic function in the biological kingdom, and it provides a fundamental basis for the analysis of various parameters of the phenomenon.

CONTENTS

Photochemical Principals
Photocontrol of Seed Germination and Vegetative Growth by Red Light
Role of Chemical Agents in Photocontrol of Vegetative Growth
Photoperiodic Control of Reproduction in Plants
Growth Factors and Flowering
Analysis of Plant Photoperiodism
The Relation of Light to Rhythmic Phenomena in Plants and Animals
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6–13. American Otorhinologic Soc. for Plastic Surgery, Miami Beach, Fla. (J. G. Gilbert, 75 Barberry Lane, Roslyn Heights, N.Y.)

7–9. Wildlife Management Inst., Dallas, Tex. (C. R. Gutermuth, 709 Wire Bldg., Washington 5.)

7–11. American Soc. of Civil Engineers, New Orleans, La. (E. S. Kirkpatrick, ASCE, 33 W. 39 St., New York 18.)

10. Recent Developments in Poultry Nutrition (Assoc. of Vitamin Chemists), Chicago, Ill. (J. T. Sime, Director of Research, Evaporated Milk Assoc., 228 N. La Salle St., Chicago 1.)

13–14. American Otological Soc., Miami Beach, Fla. (L. R. Boies, University Hospital, Minneapolis 14.)

14–16. American Railway Engineering Assoc., annual conv., Chicago, Ill. (N. D. Howard, AREA, 59 E. Van Buren St., Chicago 5.)

14–17. Positive Health of Older People, forum, Miami Beach, Fla. (A. Mallach, National Health Council, 1790 Broadway, New York 19.)

15–16. American Broncho-Esophangological Assoc., Miami Beach, Fla. (F. J. Putney, 1712 Locust St., Philadelphia 3.)

15–21. Nondestructive Testing, 3rd intern. conf., Tokyo and Osaka, Japan. (S. Ishizaka, Scientific Attaché, Embassy of Japan, 2514 Massachusetts Ave., NW, Washington 8.)

17. Congress for Pharmacists, 2nd annual, Jamaica, N.Y. (Congress for Pharmacists, Public Relations Office, St. John's Univ., Jamaica 32.)

17–19. American Radium Soc., conf., San Juan, Puerto Rico. (ARS, 635 East Union, Pasadena, Calif.)

17–19. Blood Platelets, intern. symp. (by invitation only), Detroit, Mich. (Miss S. A. Johnson, Henry Ford Hospital, Detroit 2.)

17–20. International Assoc. for Dental Research, Chicago, Ill. (D. Y. Burrill, Northwestern Univ. Dental School, 311 E. Chicago Ave., Chicago 11.)

18–19. American Laryngological Assoc., Miami Beach, Fla. (L. Richards, Massachusetts Inst. of Technology, Cambridge.)

20–23. American Assoc. of Dental Schools, Chicago, Ill. (R. Sullen, 840 N. Lake Shore Drive, Chicago 11.)

20–26. American Cong. on Surveying and Mapping, Washington, D.C. (C. E. Palmer, American Soc. of Photogrammetry, 1515 Massachusetts Ave., NW, Washington 5.)

20–26. American Soc. of Photogrammetry, Washington, D.C. (C. E. Palmer, ASP, 1515 Massachusetts Ave., NW, Washington 5.)

21–24. American Acad. of General Practice, 12th annual, Philadelphia, Pa. (AAGP, Volker Blvd. at Brookside, Kansas City 12, Mo.)

21–24. Institute of Radio Engineers, natl. conv., New York, N.Y. (L. G. Cumming, IRE, 1 E. 79 St., New York 21.)

23–25. Optical Spectrometric Measurements of High Temperatures, symp., Chicago, Ill. (F. Brech, Laboratories for Applied Science, Univ. of Chicago, 6220 S. Drexel Ave., Chicago 37.)

24–25. Human Factors in Electronics, 1st annual symp. (IRE), New York, N.Y. (J. E. Karlin, Bell Telephone Laboratories, Murray Hill, N.J.)

24–26. American Assoc. for the History of Medicine, Charleston, S.C. (J. B. Blake, c/o Smithsonian Institution, Washington 25.)

24–26. Aviation Education, 4th natl. conf., Denver, Colo. (W. Kinkley, Superintendent of Schools, Aurora, Colo.)

26–27. American Psychosomatic Soc., 17th annual, Montreal, Canada. (E. D. Wittkower, APS, 265 Nassau Rd., Roosevelt, N.Y.)

28–31. Exploitation of Natural Animal Populations, symp., Durham, England. (E. D. Le Cren, British Ecological Soc., The Ferry House, Ambleside, Westmorland, England.)

29–31. American Power Conf., 22nd annual, Chicago, Ill. (R. A. Budenholzer, Mechanical Engineering Dept., Illinois Inst. of Technology, 3300 Federal St., Chicago 16.)

29–2. National Science Teachers Assoc., 8th annual conv., Kansas City, Mo. (Miss M. R. Broom, NSTA, National Education Assoc., 1201 16 St., NW, Washington 4.)

30–31. Adrenergic Mechanisms, Ciba Foundation symp. (by invitation only), London, England. (G. E. W. Wolstenholme, Ciba Foundation, 41 Portland Pl., London, W.1, England.)

31–1. Continuous Culture of Microorganisms, symp., London, England. (R. Elsworth, c/o Ministry of Supply, Microbiological Research Establishment, Porton, Salisbury, Wilts., England.)

31–2. American Gastroenterological Assoc., New Orleans, La. (W. Volwiler, Dept. of Medicine, Univ. of Washington, Seattle.)

April

1–3. American Soc. of Internal Medicine, San Francisco, Calif. (R. L. Richards, 350 Post St., San Francisco 8.)

1–3. American Soc. for the Study of Sterility, Cincinnati, Ohio. (H. H. Thomas, 920 S. 19 St., Birmingham 5, Ala.)

1–4. Bahamas Medical Conf., Nassau. (B. L. Frank, P.O. Box 4037, Fort Lauderdale, Fla.)

2. Paleontological Research Institution, Ithaca, N.Y. (Miss R. S. Harris, 126 Kelvin Pl., Ithaca.)

2–6. American College of Obstetrics and Gynecologists, Cincinnati, Ohio. (D. F. Richardson, 79 W. Monroe St., Chicago 3, Ill.)

3–6. American Surgical Assoc., White Sulphur Springs, W. Va. (W. A. Altemeier, Cincinnati General Hospital, Cincinnati, Ohio.)

3–7. International Anesthesia Research Soc., Washington, D.C. (A. W. Friend, E. 107 St. and Park Lane, Cleveland 6, Ohio.)

3–8. Nuclear Cong., New York, N.Y. (P. Lange, Engineers Joint Council, 29 W. 39 St., New York.)

4–6. American Inst. of Electrical Engineers, Houston, Tex. (N. S. Hibsham, AIEE, 145 N. High St., Columbus 15, Ohio.)

4–6. American Inst. of Mining, Metallurgical and Petroleum Engineers (43rd Natl. Open Hearth Steel Conf. and Blast Furnace, Coke Oven and Raw Materials Conf.), Chicago, Ill. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)

4–6. American Oil Chemists' Soc., Dal-

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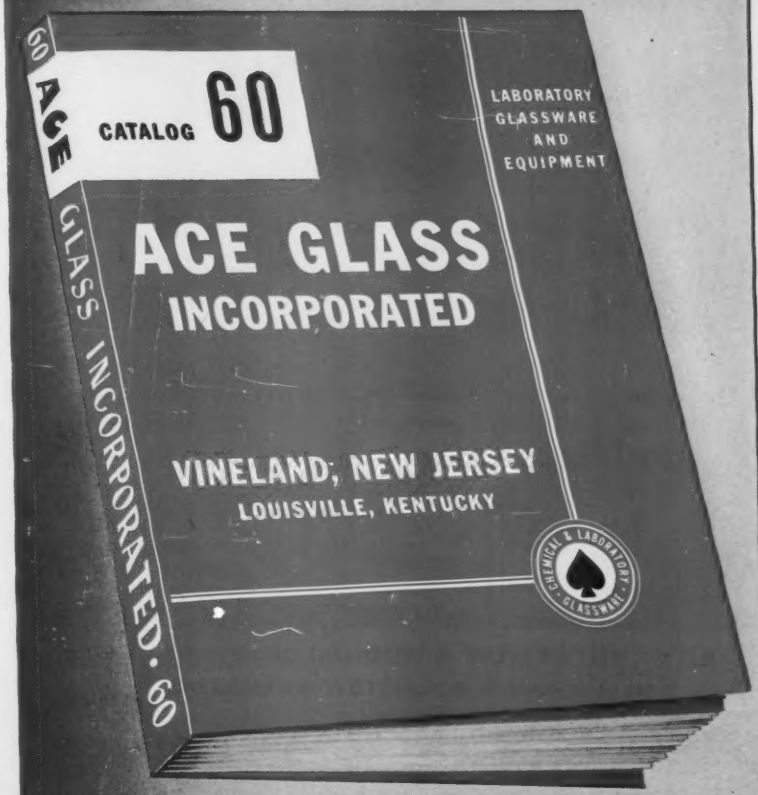

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las, Tex. (Mrs. L. R. Hawkins, AOCS, 35 E. Wacker Drive, Chicago 1, Ill.)

4–7. Atomic Exposition, New York, N.Y. (Atomic Exposition, 117 S. 17 St., Philadelphia, Pa.)

4–8. American Soc. of Mechanical Engineers, New York, N.Y. (D. B. MacDougall, ASME, 29 W. 39 St., New York.)

4–9. American College of Physicians, San Francisco, Calif. (E. R. Loveland, 4200 Pine St., Philadelphia 4.)

5–7. Instrument Soc. of America (Natl. Chemical and Petroleum Symp.), Rochester, N.Y. (H. S. Kindler, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.)

5–7. Naval Structural Mechanics, 2nd symp., Providence, R.I. (E. H. Lee, Brown Univ., Providence.)

5–14. American Chemical Soc., natl., Cleveland, Ohio. (A. T. Winstead, ACS, 1155 16 St., NW, Washington 6.)

6–8. Biochemistry and Pharmacology of Compounds Derived from Marine Organisms, symp., New York, N.Y. (R. F. Nigrelli, Dept. of Marine Biochemistry and Ecology, New York Aquarium, Seaside Park, Eighth St. and Surf Ave., Brooklyn 24, N.Y.)

6–8. Hyper-Environments—Space Frontier (Inst. of Environmental Scientists), Los Angeles, Calif. (M. S. Christensen, IES, 6251 Marita St., Long Beach 15, Calif.)

6–8. Radiofrequency Spectroscopy Group, Nottingham, England. (J. E. Ingram, RSG, c/o Dept. of Electronics, Telecommunications and Radio Engineering, Univ. of Southampton, England.)

6–9. Mineral Processing, intern. cong., London, England. (B. W. Kerrigan, Institution of Mining and Metallurgy, 44 Portland Pl., London, W.1, England.)

7–8. Cathode Protection, European symp., Frankfurt am Main, Germany. (Secrétariat du Symposium, Deutsche Gesellschaft fur Metallkunde, Alteburgerstrasse 402, Koln-Marienburg, Germany.)

7–9. American Assoc. of Railway Surgeons, Chicago, Ill. (C. C. Guy, 5800 Stoney Island Ave., Chicago 37.)

7–9. Association of Surgeons of Great Britain and Ireland, Birmingham, England. (F. A. R. Stammers, 47 Lincolns Inn Fields, London, W.C.2, England.)

7–9. Optical Soc. of America, Washington, D.C. (K. S. Gibson, OSA, Natl. Bureau of Standards, Washington 25.)

8–9. American Assoc. of University Professors, Detroit, Mich. (P. R. David, Univ. of Oklahoma, Norman.)

8–9. Southern Soc. for Philosophy and Psychology, Biloxi, Miss. (E. Henderson, Florida State Univ., Tallahassee.)

8–11. American Dermatological Assoc., Boca Raton, Fla. (W. M. Sams, 308 Ingraham Bldg., Miami 32, Fla.)

9–10. Histochemical Soc., 11th annual, New York, N.Y. (H. W. Deane, Albert Einstein College of Medicine, Bronx 61, N.Y.)

11–13. American College of Surgeons, Minneapolis, Minn. (H. P. Saunders, 40 E. Erie St., Chicago 11, Ill.)

11–14. American College Personnel Assoc., Philadelphia, Pa. (M. D. Hardee, Florida State Univ., Tallahassee.)

11–15. American Assoc. of Immunologists, Chicago, Ill. (C. Howe, Columbia Univ., College of Physicians and Surgeons, New York 22.)

11–15. American Inst. of Nutrition, Chicago, Ill. (G. M. Briggs, Div. of General Medical Sciences, National Institutes of Health, Bethesda, Md.)

11–15. American Physiological Soc., Chicago, Ill. (R. G. Daggs, 9650 Wisconsin Ave., NW, Washington 14.)

11–15. American Soc. for Experimental Pathology, Chicago, Ill. (F. J. A. McManus, Univ. of Alabama Medical Center, Birmingham.)

11–15. American Soc. for Pharmacology and Experimental Therapeutics, Chicago, Ill. (K. H. Beyer, Merck Sharp & Dohme Research Laboratories, West Point, Pa.)

11–15. Federation of American Socs. for Experimental Biology, Chicago, Ill. (M. O. Lee, 9650 Wisconsin Ave., NW, Washington 14.)

11–16. American Assoc. of Anatomists, New York, N.Y. (L. B. Flexner, Dept. of Anatomy, School of Medicine, Univ. of Pennsylvania, Philadelphia 4.)

11–16. American Soc. of Biological Chemists, Chicago, Ill. (F. W. Putnam, Dept. of Biochemistry, Univ. of Florida, Gainesville.)

11–16. Anatomical Congress, 7th intern., New York, N.Y. (D. W. Fawcett, Dept. of Anatomy, Harvard Medical School, Boston 15, Mass.)

11–16. Congress of Anatomy, 7th intern., New York, N.Y. (J. C. Hinsey, New York Hospital, Cornell Medical Center, 525 E. 68 St., New York 21.)

11–16. International Anatomical Cong.,

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New York, N.Y. (D. W. Fawcett, Dept. of Anatomy, Cornell Univ. Medical College, 1300 York Ave., New York 21.)

13–15. American Public Health Assoc. (Southern Branch), Memphis, Tenn. (L. M. Groves, Shelby County Health Dept., Memphis.)

15–16. Eastern Psychological Assoc., Atlantic City, N.J. (C. H. Rush, Standard Oil Co. (N.J.), Rockefeller Plaza, New York, N.Y.)

18–21. American Astronomical Soc., Pittsburgh, Pa. (J. A. Hynek, Smithsonian Astrophysical Observatory, 60 Garden St., Cambridge 38, Mass.)

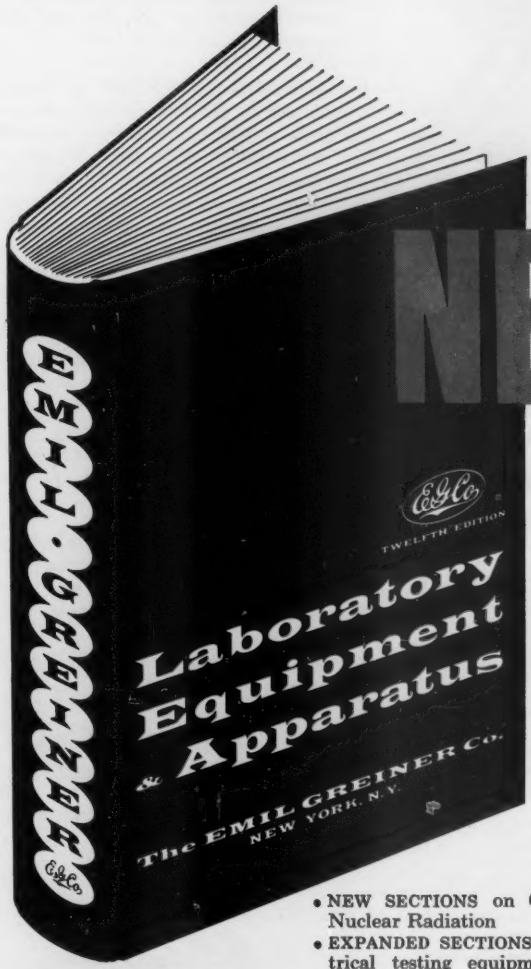
18–22. Association of American Geographers, Dallas, Tex. (A. C. Gerlach, Map Div., Library of Congress, Washington 25.)

18–22. European Soc. of Opthalmology, 1st cong., Athens, Greece. (P. Velissaropoulis, c/o Opthalmology Clinic, Faculty of Medicine, 26, rue de l'Université, Athens, Greece.)

19–21. Active Networks and Feedback Systems, 10th intern. symp., New York, N.Y. (H. J. Carlin, Microwave Research Inst., Polytechnic Inst. of Brooklyn, 55 Johnson St., Brooklyn 1, N.Y.)

19–21. American Soc. of Lubrication Engineers, annual, Cincinnati, Ohio. (C. L. Willey, ASLE, 84 E. Randolph St., Chicago, Ill.)

(See issue of 15 January for comprehensive list)



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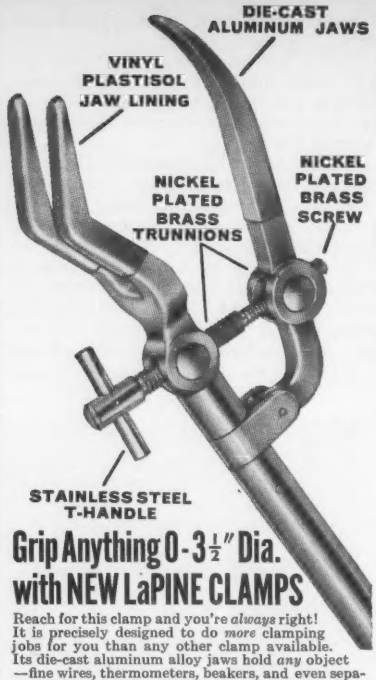

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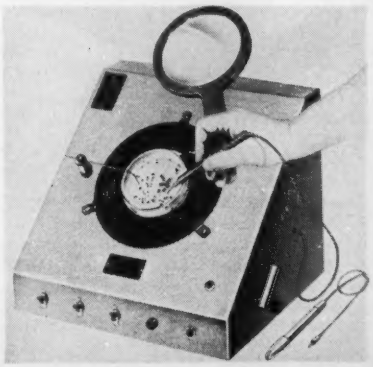
■ ELECTRON ACCELERATOR for irradiation furnishes 0.5 Mev electrons with 7.5 kw output at constant potential. Scan widths up to 36 in. are available. High voltage is produced by a cascaded rectifier driven in parallel from an RF oscillator at 300 kcy/sec. Dimensions are 3 ft in diameter by 6 ft long, exclusive of beam extension system. (Radiation Dynamics, Inc., Dept. Sci289, Westbury, L.I., N.Y.)

■ OSCILLATOR, model 350, can be programmed to generate up to 11 frequencies in any desired sequence. Accuracy is said to be ±0.01 percent of generated frequency over the range 100 cy to 100 kcy/sec. Operating modes include automatic stepping, push-button stepping, and manual setting by means of six decimal switches. (Digital Instrument Laboratories, Dept. Sci290, East Los Angeles, Calif.)

■ WIND VANE measures both vertical and horizontal wind components. Maximum overshoot is 15 percent. A companion recorder provides a permanent record of the instrument output. (Gelman Instrument Co., Dept. Sci306, Chelsea, Mich.)

■ BACTERIAL COLONY COUNTER actuates a counting mechanism on contact of a probe with an agar medium and simultaneously makes an identifying puncture. A self-actuating marking pen is used where puncturing is not feasible. The latter leaves a small, easily removable ink spot on the glass or plastic plate. A fixed pushbutton actuator and a hand-held pushbutton are also provided. Count is registered on a four-digit electromagnetic counter. (New Brunswick Scientific Co., Dept. Sci278, New Brunswick, N.J.)



■ AIR-PARTICLE SAMPLER incorporates a nine-stage turbine type air mover designed for continuous operation. A metering system indicates on a resettable counter the total volume of air that has passed through the filter during the sampling period. Diameter of the filter holder is 2 in. Other sizes can be furnished. Collection rate is 16,800 lit./hr. Operation is on 115 volts a-c. (Nems Clark Division of Vitro Corporation of America, Dept. Sci298, 919 Jesup-Blair Dr., Silver Spring, Md.)

■ BATTERY VOLTAGE REGULATOR is a transistorized magnetic-amplifier device intended to overcome problems of voltage decay in battery supply sources. The device is said to maintain output voltage ±2 percent with battery supply voltage drop of 20 to 30 percent. Efficiency is said to be 80 to 85 percent. Operating temperature range is −20° to +165°F. (Gulton Industries, Inc., Dept. Sci297, 212 Durham Ave., Metuchen, N.J.)

■ GRAPHIC PERIODIC ELEMENT SELECTOR illustrates electron structure and furnishes information on atomic number, atomic weight, valence, melting and boiling points, density, abundance, electronegativity, oxidation potential, covalent bond types, ionization potential, isotopes, ionic and covalent radius, and heat of formation. A slide-rule arrangement determines ionic character in chemical bonds. (Graphic Calculator Co., Dept. Sci302, 633 S. Plymouth Ct., Chicago 5, Ill.)

■ TEST TUBE INCUBATOR of waterless design provides controlled temperature at 37° ± 0.5°C. The incubator accommodates 40 test tubes from 10 to 13 mm in diameter. Up to 2 ml can be incubated in each tube. Operating temperature is reached in 30 min. Dimensions are 9.5 by 7 by 3 in. Operation is on 115 volts a-c. (Clay-Adams, Inc., Dept. Sci304, 141 E. 25 St., New York 10, N.Y.)

■ ORGANIC-CARBON DETECTOR is a portable, self-contained instrument that permits analysis of total organically bonded carbon in atmosphere or gases. Sensitivity is said to be 10^{-7} for such compounds as hydrocarbons, aldehydes, ketones, alcohols, and amines. Range is adjustable from 0 to 0.0001 percent to 0 to 10 percent. The instrument operates by feeding the metered sample into a hydrogen flame that ionizes combustibles to effect changes in current flow proportional to total carbon content. Response time is less than 2 sec. (Perkin-Elmer Corp., Dept. Sci317, Norwalk, Conn.)

■ IONIZATION CHAMBERS are spherical in shape with elimination of dead space. Saturation is said to be obtained at 90 volts or less for all ordinary currents. Electrode insulators are guarded. An 18-mm spherical joint and valve permit connection to the chamber. A slide chamber of 600-ml capacity holds two sample planchets of diameter 2¼ in. or less. (Applied Physics Corp., Dept. Sci309, 2724 South Peck Rd., Monrovia, Calif.)

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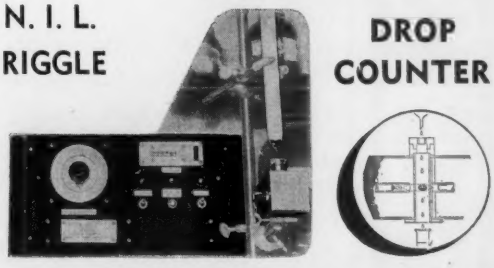

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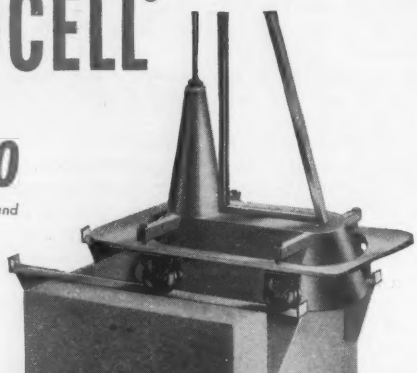

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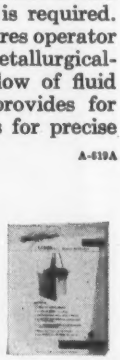

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■ DIGITAL PLOTTER uses two digital-to-analog converters, one each for x and y signals, and two servo systems that position a printing mechanism according to binary-coded x and y input signals. Charts, 8½ by 11 in. and 11 by 16 in., are held by a vacuum system. Slewing speed is 5 in./sec, and accuracy is said to be ±0.1 percent of full scale. Plotting rate for 0.1 percent accuracy is 1.6 points per second, zero to full scale. Up to six identification symbols are provided on the print wheel. (Gerber Scientific Instrument Co., Dept. Sci313, 89 Spruce St., Hanford, Conn.)

■ OPERATIONS RECORDER provides six channels of on-off data and one analog channel. Accuracy of the latter is ±2.5 percent. Frequency response is 0 to 600 cy/sec for the analog channels. The recorder operates only upon change of the incoming signal with chart motion response 19 msec for 63 percent of operating speed. Time of record is recorded to the nearest minute. (Hamilton Watch Co., Hathaway Instrument Div., Dept. Sci314, 5800 East Jewell Ave., Denver 22, Colo.)

■ VOLTAGE DIVIDER for alternating current is a six-decade resistive device said to be accurate to ±0.0002 percent for frequencies from d-c to 4000 cy/sec over the temperature range 20° to 30°C. Accuracy at 10 kcy/sec is said to be decreased to ±0.0005 percent. Over-all resistance is 10,000 ohm and resolution is 0.0001 percent. Circuit design permits grounding either the low end or the output arm of the divider. (Julie Research Corp., Inc., Dept. Sci316, 556 W. 168 St., New York 32, N.Y.)

■ CENTRIFUGE, for calibration of vibration measuring instruments, generates sinusoidal accelerations at frequencies up to 20 cy/sec. The machine consists of a small satellite table mounted on a large table so arranged that the angular velocity of the small turntable is zero while it orbits about the main spindle of the machine. Radial separation of the two spindles is adjustable up to 12 in. Speed indication is provided. Slip rings provide electrical connections to rotating objects. (Schaevitz Machine Works, Dept. Sci315, Pennsauken, N.J.)

■ ENCAPSULATING COMPOUND is an epoxy resin suitable for dip-coating of small electrical components. The material is thixotropic so that dripping does not occur on withdrawal at cure temperatures as high as 160°C. (Houghton Laboratories Inc., Dept. Sci299, Olean, N.Y.)

■ RADIOFREQUENCY VOLTMETER is said to have accuracy of ±1 percent or better from d-c to 100 Mcy/sec. The instrument is a thermocouple type with vacuum theromocouple and multiplying resistor in a shielded case separate from the indicating meter. Construction is of coaxial-cavity type with coaxial input connector. (Rawson Electrical Instrument Co., Dept. Sci312, Cambridge, Mass.)

■ REFRACTOMETER makes a continuous comparison between a reference liquid and a flowing sample. Changes in concentration are indicated or recorded. The instrument uses null balance with servomechanism restoration of balance. The stainless-steel sample cell is contained in a water bath for temperature constancy. An external heat exchanger may also be used. (Hilger & Watts, Ltd., Dept. Sci310, 98 St. Pancras Way, Camden Rd., London N.W.1, England)

■ INDUCTANCE BRIDGE is designed for measurement of series or parallel components of two-terminal grounded inductors at audio frequencies. Inductance range extends to 1111 hy and minimum indication is 0.001 μh. Direct-reading accuracy at frequencies up to 1 kcy/sec is said to be ±0.1 percent, and comparison of two inductors of nearly the same nominal value to be possible to ±0.01 percent. The instrument is usable to 10 kcy/sec (higher with some reduction in accuracy). (General Radio Co., Dept. Sci318, West Concord, Mass.)

■ ANALOG COMPUTER is a ten-amplifier instrument weighing 23 lb. For solving more complex problems, up to three computers can be slaved together. Each computer includes, in addition to amplifiers, a null voltmeter, five coefficient

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or initial-condition potentiometers, and all power supplies and control circuitry. For educational use, the computer's 19-in. problem board can be replaced by two smaller boards allowing separate operation of each half of the computer without interference. Various accessories are available. (Donner Scientific Co., Dept. Sci319, Concord, Calif.)

■ WAVE-FORM SYNTHESIZER produces wave form desired by controlling the characteristics of small segments of the total wave form. Type A plug-in units permit amplitude and slope of each of 50 increments to be independently varied. Type B units provide 50 output pulses with variable width as well as amplitude. Over-all amplitude and duration are also variable. (Exact Electronics Inc., Dept. Sci322, P.O. Box 552, Portland 7, Ore.)

■ RECORDING VACUUM BALANCE is a standard symmetrical beam balance mounted on a heavy aluminum base plate and covered by a bell jar. A set of switch weights operated by cams is suspended from the right stirrup. Beam deflection is detected by a variable inductance transducer in a bridge circuit and recorded. Whenever the recorder pen approaches either edge of the recorder chart, a weight is automatically added or subtracted. Automatic ranges, equivalent to 40 chart widths, are 400 and 4000 mg, respectively, in two models. Corresponding weighing accuracies are ±0.03 and ±0.2 mg, respectively. A two-pen recorder permits simultaneous temperature recording. (William Ainsworth and Sons, Inc., Dept. Sci327, 2151 Lawrence St., Denver, Colo.)

■ POLAROGRAPH RANGE EXTENDER is said to permit measurements at lower concentrations. The accessory provides measuring resistors of higher value for increased current sensitivity, and supplies to the measuring system a suppressing voltage equal and opposite in sense to the capacitance current. The latter is applied at a linear rate of change by a synchronous-motor-driven bridge turning simultaneously with the polarizing bridge. (E. H. Sargent & Co., Dept. Sci300, 4647 W. Foster Ave., Chicago 30, Ill.)

■ NOISE MEASURING EQUIPMENT is a narrow-band radio-frequency spectrum analyzer for spurious AM and FM modulations at close to carrier frequency. Carrier-frequency ranges from 5.4 to 14.1 kMcy/sec can be supplied. Spectrum analyzer range is 500 cy to 90 kcy/sec. Resolution is 70 cy or 1 kcy/sec. AM sideband power in a 70 cy/sec band width can be measured down to −135 db relative to total signal power level with ±2 db accuracy. (Ferranti Electric Co., Dept. Sci324, 95 Madison Ave., Hempstead, N.Y.)

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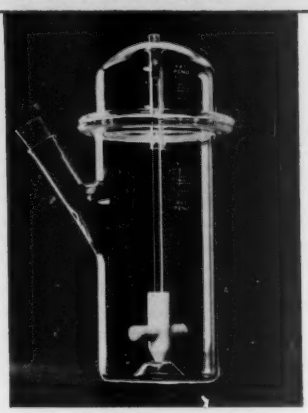

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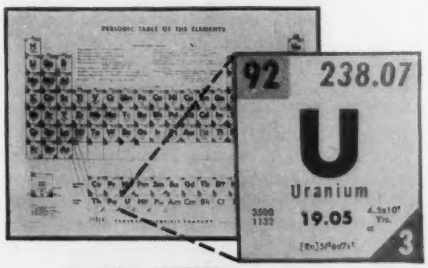

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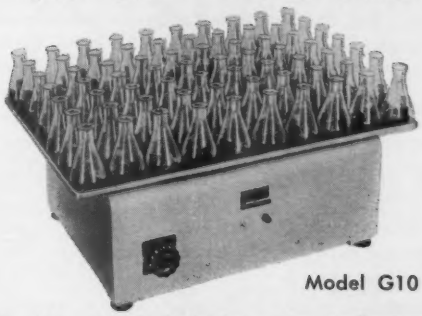

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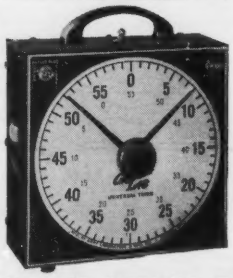

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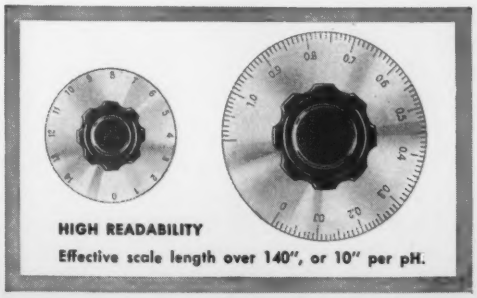

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Nestled in with the Nuclear-Chicago instruments in the above photograph you will find six bulletins we have prepared to help familiarize you with various ways radioactivity is being used in research today. These four-page bulletins describe, in a concise and stimulating way, common analytical and process applications of radioisotopes, procedures that offer great advantages over time consuming, expensive and often inaccurate non-isotopic analytical methods*. We will be glad to send you all six of these bulletins without obligation. Just write us for Technical Bulletins Nos. 1 through 6.

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***The applications described in these bulletins are, No. 1: How to Use Radioisotopic Yield Determination in Quantitative Analysis. No. 2: How to Use Radioisotopic Analysis for Mixing Evaluation. No. 3: How to Use the Radioisotopic Derivative Method in Quantitative Analysis. No. 4: How to Use Radioactivity in Paper Chromatography. No. 5: How to Evaluate an Analytical Method with the Aid of Radioisotopes. No. 6: How to Make Quantitative Determinations by Radiometric Analysis.**